RAID

HEROES OF TELEMARK

Sabotaging Hitler's atomic bomb, Norway 1942–44

DAVID GREENTREE

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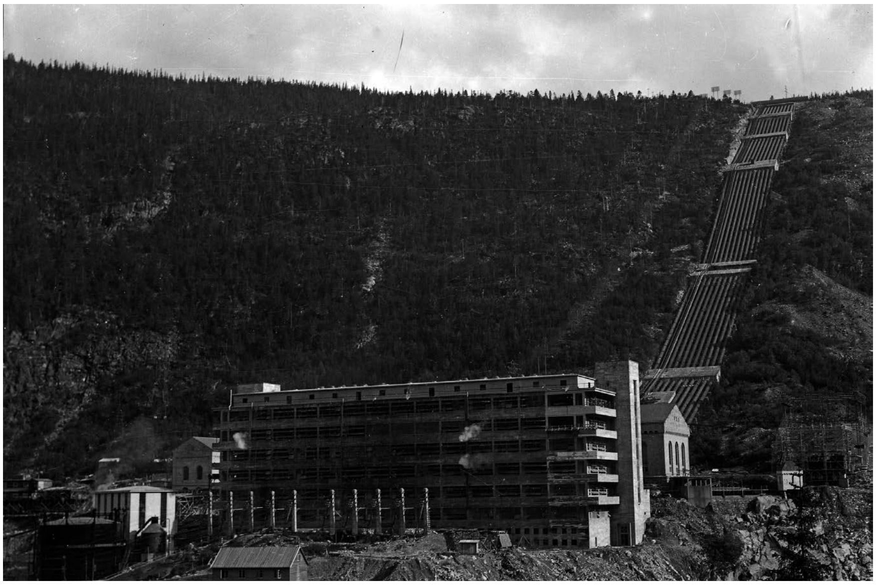

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OSPREY PUBLISHING
Bloomsbury Publishing Plc
PO Box 883, Oxford, OX1 9PL, UK
1385 Broadway, 5th Floor, New York, NY 10018, USA
E-mail: info@ospreypublishing.com
www.ospreypublishing.com

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This electronic edition published in 2018 by Bloomsbury Publishing Plc

First published in Great Britain in 2018

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A catalogue record for this book is available from the British Library.

ISBN: PB 9781472827678; eBook 9781472827661;

ePDF 9781472827654; XML 9781472827647

Index by Sandra Shotter
Maps by bounford.com
3D BEV by Alan Gilliland

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ACKNOWLEDGEMENTS

I would like to thank Ingelinn Kårvand, the photo archivist at the Norsk Industriarbeidermuseum, for the helpful support she provided with sourcing many of the images within this book. Also Hanne Rollag and Professor Sigurd Stenwig at the Norges Hjemmefrontmuseum were equally generous with their help with images and providing a copy of Joachim Rønneberg's report on the raid. Thanks also to David Campbell, who provided valuable advice and help with the artwork.

COVER ART

Following the successful demolition of the Vemork electrolysis room, the Norwegian SOE saboteur Claus Helberg was spotted in the Jansbu cabin refuge and tried to escape on skis. But this pursuing German soldier was faster downhill and ordered Helberg to raise his hands. Instead Helberg turns to fire his Colt .45 pistol, but misses. He lets the soldier fire off all his rounds, hoping he will miss at this range with the sun interfering with his aim. The German's shots are wide and Helberg will ski closer to shoot from 30yds. He hits the German who crumples on his ski poles.

ARTISTS' NOTE

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INTRODUCTION

In May 1941 a dossier landed on the desk of the head of the Norwegian Section of the Special Operations Executive (SOE) in London warning of the dangers of heavy water. SOE was created in 1940 by the Minister of Economic Warfare, Hugh Dalton. He wanted to use industrial and military sabotage to wage war against Germany and use SOE to coordinate, inspire, control and help nationals of occupied countries to conduct such attacks. SOE agents would also promote disaffection in occupied territories and hamper the enemy's war effort. The military at first resented SOE because many members were civilians. The organisation at the start of 1942 had a poor reputation and was in need of a success.

Heavy water was a key component in the making of the atom bomb, which envisaged a plutonium core encased in high explosive. On detonation huge amounts of energy would be released as a chain reaction split the atom. Plutonium is not naturally occurring and needed to be created in a reactor by bombarding the element uranium with neutrons. The Germans needed a braking material to control this reaction. Electrolysed 'heavy' water was such a material however, its production took time and few stockpiles existed. The Norsk Hydro Plant in the Telemark region of Norway at Vemork manufactured fertiliser and heavy water was a by-product. The Germans intended to utilise the material in their atomic weapons research programme. They had to be stopped.

Research into atomic energy had started to progress in the 1930s. The physicist Ernest Rutherford had discovered that unstable elements such as uranium could break down and give off huge amounts of energy. In 1932 J. Chadwick found out that a neutron hitting the atom could facilitate this break down. The neutron was heavy and had no charge to hinder movement, but it could be absorbed by atoms or could throw out a proton. In 1938 Otto Hahn, a German chemist, discovered that a neutron hitting a uranium atom could split the atom – called fission – with tremendous force. Neutrons from the split atom could then split other atoms, creating

1935

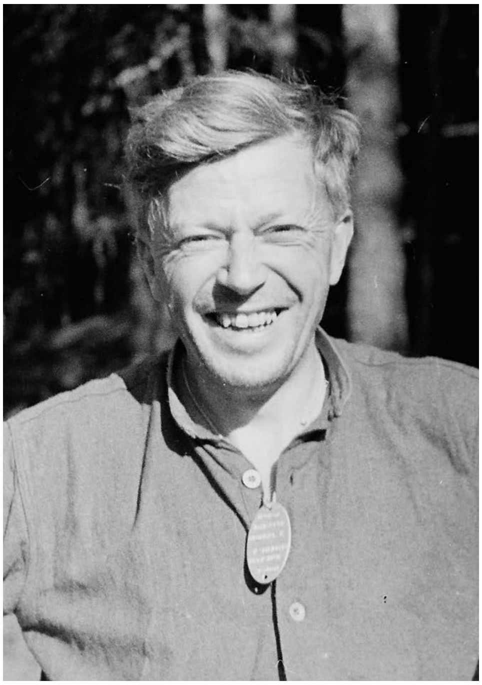
Heavy water production begins at Vemork

a chain reaction. The future military potential of this reaction being weaponised was fully realised if not immediately achieved.

Soon after the German invasion of Norway in April 1940, a Norwegian professor in Trondheim, Leif Tronstad, was recruited to spy for the Allies and from his friend Jomar Brun, the chief manager of the Norsk Hydro Plant in Vemork, learnt of the importance the Germans were attaching to heavy water production at Vemork and reported back to the Secret Intelligence Service (SIS) in London. By September 1941 the Germans were closing in on Tronstad's activities and he was forced to leave Norway via Sweden. Tronstad reached London and became head of intelligence of the Norwegian government in exile; he was an ideal person to be in charge of investigating Vemork. In 1933 Tronstad and Brun had suggested a heavy water production facility as part of the power plant situated there. They produced designs for a high concentration method that recycled the heavy water (given off as gas during electrolysis) to give purity levels of heavy water of 99.5 per cent. In 1935 production started and the following year 88lb was produced, in 1938 176lb, but sales were limited. When German scientists proved that heavy water enabled the slowing down of neutrons, interest increased. The Norsk Hydro Plant was at first unaware of the use their heavy water could be put to in atomic research.

Heavy water is in normal water but in a minute quantity and comprises hydrogen atoms that have deuterium, an isotope that has a neutron as well as a proton, making an atomic weight of two rather than one. Extracting heavy water is time-consuming and costly. Rare in nature (in every 41 million molecules of ordinary water there is a molecule of heavy water), if enough electricity passed through ordinary water, the heavy water molecules broke down slower and could be distilled, but the production of 2lb of heavy water required 50 tons of ordinary water and 320,000kw hours of electricity and the purity of this heavy water at first was very low.

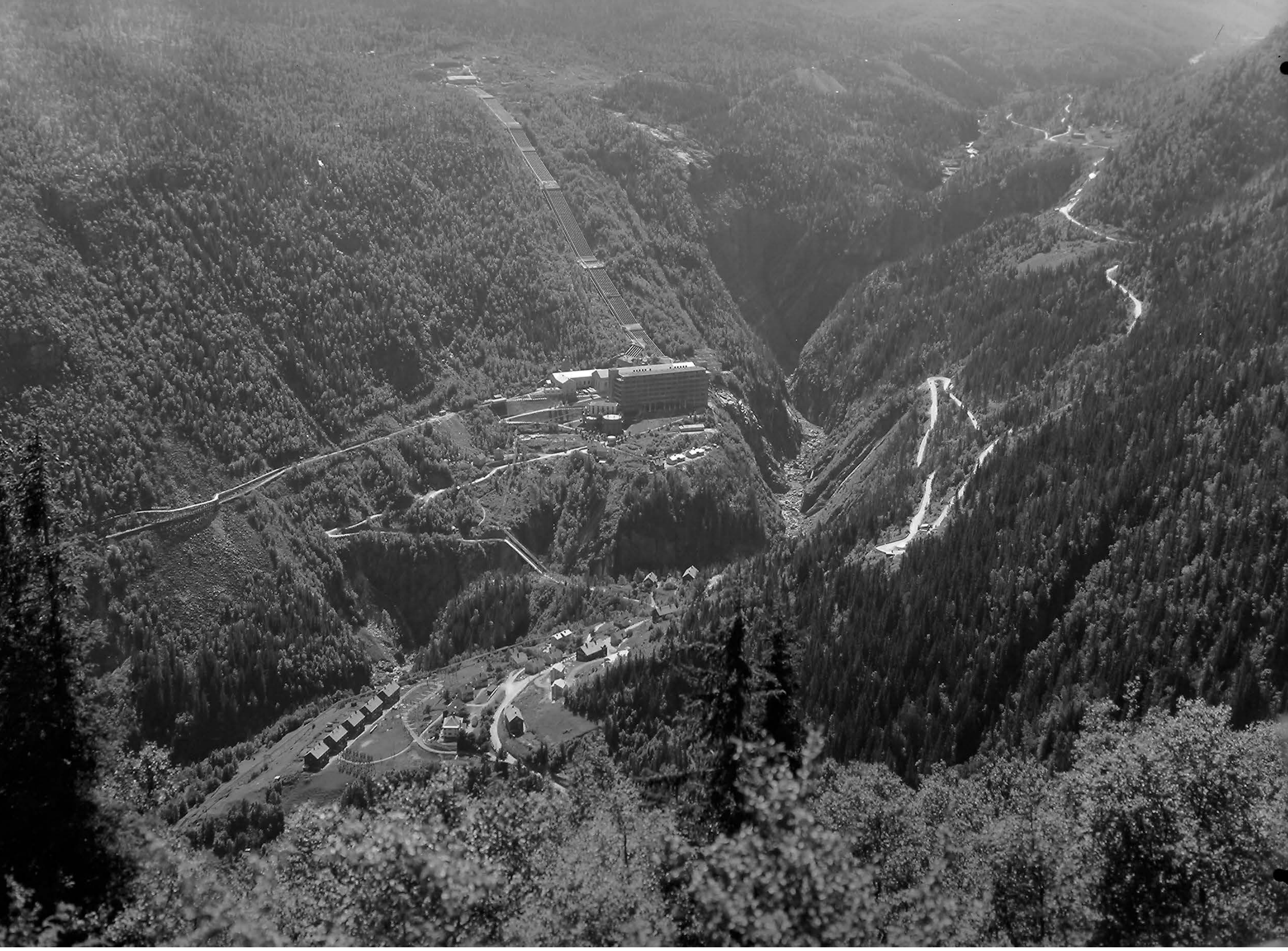
Vemork was situated at the south-east corner of the vast, desolate Hardanger Plateau. Most of the water from the Hardanger flowed into Lake Møs and then the Måna River, which in turn flowed into Lake Tinnsjø. Norsk Hydro had built a dam on Lake Møs to alter the flow of the water into the hydroelectric plant it had constructed at Vemork on the slopes above the river. A fraction of the water fed a hydrogen plant where electrolysis cells split the hydrogen atoms in the water from the oxygen atoms. The hydrogen was pumped into chemical plants in Rjukan in the valley to make fertiliser. Other specialist electrolysis cells in a cellar in Vemork reduced some of the water further into heavy water. Intelligence reports received from Norway told how Germany was developing new



Leif Tronstad completed a six-week Norwegian Army training course in Scotland and was appointed a captain. As head of Section IV of the Norwegian High Command he was tasked with intelligence, espionage and sabotage. He was uniquely placed to determine what information was needed to complete the intelligence picture. (Norsk Industriabeidermuseum. Foto: Kårvand, Ingelinn)

APRIL 1940

Germany invades Norway



Vemork was remote; in a narrow valley that only had a single road, at the foot of the inhospitable Hardanger Plateau and on a cliff above a steep gorge. (Norsk Industriabeidermuseum. Foto: Ukjent)

methods to enhance purity levels and that in May 1941 it had ordered the plant at Vemork to increase yearly production to 3,000lb and to 10,000lb by February 1942.

While SIS was responsible for gathering intelligence about Vemork, the SOE was involved in sabotage and was tasked with destroying the Norsk Hydro Plant; however, sabotage operations could interfere with intelligence gathering and was frowned upon by SIS. Gestapo activity increased when SOE carried out acts of sabotage and put SIS operatives in danger. Intelligence to be used properly would have to flow between the spies working in the plant and those planning the attack. SIS needed to successfully gather information about the layout of the plant to facilitate SOE's sabotage.

MAY 1941

SOE is warned about the uses of heavy water

ORIGINS

The race for the atomic bomb

The race for heavy water had begun before Germany invaded Norway. The French physicist, Frédéric Joliot-Curie, won the Nobel Prize when he discovered that stable elements could be made radioactive and in early 1940 persuaded the French Armaments Minister, Raoul Dautry, that he needed heavy water for his research. J. Allier worked for a bank that owned a large amount of shares in Norsk Hydro; he reported that the Germans had placed orders for heavy water. The Germans had suggested to Norsk Hydro they would want 2 tons, but had not said to what use they would put the material. Allier was given the support of French intelligence to acquire Norsk Hydro's supplies before the Germans did, but by the time he reached Oslo German military intelligence were on to him.

Following the start of the war, the German nuclear physicist, Kurt Diebner, had held a meeting of scientists at the Army Ordnance Research Department in Berlin on 16 September 1939 to decide whether the atom's energy could be harnessed for the production of weapons or electricity. Hahn tried to persuade the meeting that creating nuclear energy or nuclear weapons was too problematic. He knew that only the rarer U-235 uranium isotope would split readily; the common U-238 isotope tended to absorb neutrons that struck the nucleus. Natural uranium contains only 0.7 per cent U-235, and separating the two isotopes is extremely difficult. Despite the problems of obtaining enough U-235, the meeting still tried to pursue the idea. The Uranverein (Uranium Club) was formed to build a nuclear reactor. On 26 September another meeting was held with the theoretical

Einar Skinnarland was the son of the dam keeper on Lake Møs. He had joined the resistance and was arrested in September 1941 when an informant named him as hiding weapons; none were discovered. He asked to be trained as a radio operator and in March 1942 with others commandeered a steamer and sailed for Britain. On 28 March 1942 he returned to Norway as a sergeant after spending two days at Special Training School (STS) 52, the radio school. He was soon at work in Vemork, sending reports gathered from workers at the plant and resistance fighters in Rjukan. (Norsk Industriabeidermuseum.Foto: Longum, Per)

physicist Werner Heisenberg in attendance; they agreed he would work on chain reaction theory and identified heavy water and graphite as moderators that could slow down the reaction. Uranium oxide was ordered; however, Diebner dismissed the idea of building a heavy water facility. Supplies of heavy water would be bought from Vemork through IG Farben, which owned 25 per cent of the shares in Norsk Hydro, in order to avoid suspicion. 220lb per month was required.

The Norwegians had agreed to supply the French rather than the Germans with what they had. On 9 March 1940 the heavy water in flasks departed Vemork and on 12 March Allier, with the help of French operatives, arrived at Fornebu airfield in Oslo; they had booked two flights – to Amsterdam and Perth in Scotland – under assumed names. Their bags were loaded on the Amsterdam flight but they boarded the Perth flight. At the last moment the heavy water in the flasks was placed on the Perth flight. The Amsterdam flight was intercepted by the Luftwaffe and the plane was forced to land at Hamburg. The next day the other batch of flasks also boarded a flight for Perth. All the heavy water was brought to Paris.

Jens-Anton Poulsson was from Rjukan and had watched the building of the plant, as the family home was nearby. His father had worked as an engineer at Vemork and Poulsson knew the outdoor life on the Hardanger. His family still lived in Rjukan and owned 10,000 acres on the Hardanger, but when operating with SOE there he was told not to have any contact with them. When he was 20 he joined the NCO school of the Norwegian Army and had retreated with his unit into Sweden without engaging the enemy. He returned to Rjukan, but decided that he would join the Norwegian government in exile and escaped to Sweden; as there were no flights to Britain it took nine months, starting in the Soviet Union, to reach London. (Norges Hjemmefrontmuseet)

In 1940 Tronstad had not yet realised the military use of heavy water; he lectured at Trondheim University and worked for the resistance. In March 1941 Brun reported to him the Germans wanted Vemork to increase production of heavy water. SIS approached Tronstad with requests for information on the heavy water plant. In the summer of 1941 Brun reported the Germans were seeking an increase to 11,023lb per year. The dangers of staying in Norway were obvious, especially as German counter-intelligence was increasing its surveillance measures. Resistance operators were being arrested in September; Tronstad was warned of his imminent detention and he crossed the border to Sweden on 26 September. He went to Britain and was debriefed by SIS in October. He briefed the British scientific community and participated in meetings that discussed how to stop heavy water production at Vemork. The Air Ministry wanted to bomb the plant, but Tronstad dismissed the idea and instead suggested sabotage from the inside.

By July 1941 the Maud Committee (formed in April 1940 to investigate the production of the atom bomb) had put together a report on how to produce a bomb. In August 1941 Churchill gave his approval and the Directorate of Tube Alloys was formed. Churchill's scientific advisor, Lord Cherwell, advised that a nuclear bomb could be produced within two years. Such a bomb weighing 1 ton, he said, would be able to explode with a force of 2,000 tons of conventional explosive. Instead of uranium U-238, a new element, U-239 (plutonium), was discovered that was produced when U-238 absorbed a neutron. As plutonium was chemically different, the element could be separated from uranium with less effort.

Second in command of Poulsson's team was Knut Haugland, also from Rjukan. In 1940 he was a radio operator aboard a merchant ship when he was called up to fight the invasion and operated as a forward observer for artillery at Narvik, locating targets and reporting them through. He worked at a radio factory in Oslo and joined the resistance. He evaded capture when he was named by an informant. At STS 52 the instructors thought he was as good as them. (Norges Hjemmefrontmuseet)

In 1941 SOE had received intelligence about Vemork from their agent Odd Starheim, a wireless operator who had visited the Hardanger. On a visit to Oslo in January 1942, he was arrested by the Gestapo in what he thought was a safe house, but escaped through the side door of a toilet and jumped from a window. Despite injuring himself, he persuaded a driver to get him out of the immediate vicinity. He was known to the authorities and was no longer capable of operating on the Hardanger. LtCol J. Wilson, the head of Norwegian SOE, ordered him to return to Britain. A ship called the *Olav* was not able to land because of the weather and so Starheim decided to commandeer a vessel. He would be helped by an engineer, Einar Skinnarland, from the hydroelectric dam on Lake Møs. Skinnarland was targeted by SOE to be a radio operator and told to go with Starheim. He would be carrying with him intelligence relating to Vemork.

In March 1942 they boarded a vessel called the *Galtesund*, a 170ft coastal steamer in Flekkefjord. They had Colt .45 pistols. As cover, they wore the badge of the Nasjional Samlung (National Unity Party) – the Norwegian fascists that were formed by Quisling, the leader of Norway installed by the Germans. Soon they revealed their intentions and forced the captain to sail to Scotland. A storm served to hide their progress, as did low-lying cloud the next day. The RAF sent a plane to escort them in and Skinnarland, taken to London, was persuaded by Wilson to return to Vemork following a shortened version of SOE training. Told of the plan to sabotage Vemork and destroy the heavy water, his aim was to find out what security measures and defences the Germans had in place. He was to send this information to Sweden by courier rather than use a radio. He knew workers at the Norsk plant. He spoke English fluently, was a champion skier and a radio operator. His home was in Rjukan, the local village. He would continue working at the Møs Dam and explain his absence as a skiing trip. Only his brother, Torstein, knew where he had really gone.

In April 1942 the Directorate of Tube Alloys met to discuss a report sent by Skinnarland that said Vemork was producing 264lb of heavy water per month and although it at first thought attacking the plant would reveal the importance it gave the heavy water, it decided that the destruction of the plant should be given the highest priority. The electrolysis cells were situated in the basement of a concrete building that stood on a steep cliff side. Night bombing would not work as there was not enough darkness in the summer months to protect the aircraft from interception (the Norwegian authorities also vetoed a bombing raid) and there was insufficient intelligence to plan a successful ground attack.

Tronstad was tasked with finding out information on the plant and in May wrote to Brun. Skinnarland was obtaining his information from Torstein's

Wilhelm Rediess (seen here on the left) had served briefly in the infantry in 1918. In the 1920s he joined the Sturmabteilung (SA), the military wing of the Nazi Party. In 1930 he had moved on to the Schutzstaffel (SS). That organisation would supersede the SA and promotion was swift; by 1935 he was an Obergruppenführer. He was responsible for implementing racial laws in Prussia and then moved to Norway following the invasion in 1940. He had an uncompromising attitude to security and would execute hostages following attacks by the resistance. (Bundesarchiv Bild 121-1386 Foto: o.Ang)

brother-in-law Gunnar Syverstad, a laboratory assistant at the plant, and knew nothing of Brun as a source. Brun reported to Tronstad a meeting in October 1941 that stated Vemork had produced only 859lb of heavy water since the invasion. Brun had visited Berlin to meet with Diebner but had not found out why the Germans wanted the figure increased to 11,023lb per year. He was told to double the number of heavy water cells to 18 and introduce a nine-stage cascade with 43,000 electrolysis cells. His personal efforts at sabotaging the chemical reactions by pouring castor oil into the cells were achieving only a slight effect. However, he photographed the plant and made drawings, which were smuggled with the help of Skinnarland from Vemork through Sweden to Tronstad in London. Meagre security was reported with too much reliance on the surrounding natural defences.

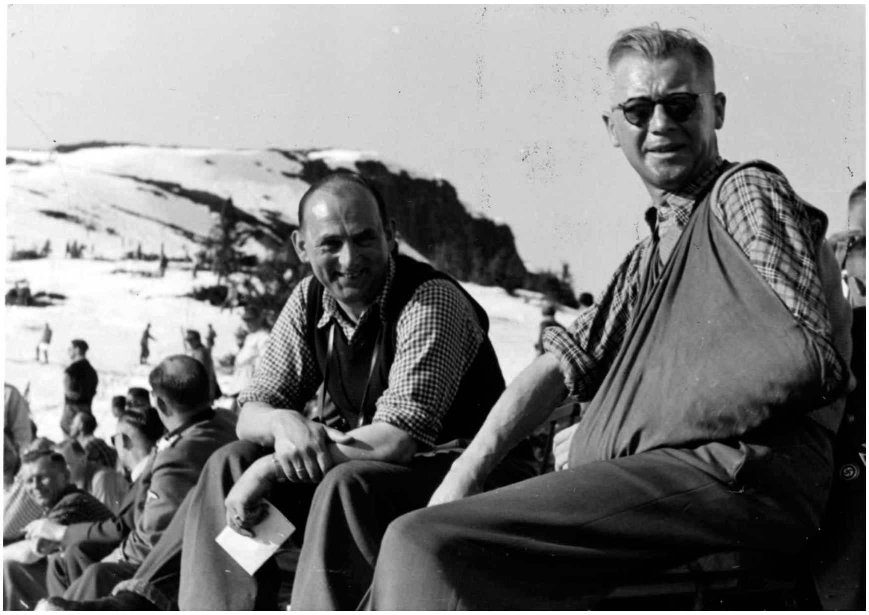
Churchill reported all this intelligence to American President Franklin D. Roosevelt in June 1942 at a meeting in Washington, when the importance of preventing the Germans producing stockpiles of heavy water was discussed. The US had financed their atomic research with $500 million and their 'Uranium Committee' was convinced that the Germans had a working nuclear reactor. When Churchill returned to London, the War Cabinet was tasked with developing a plan for a raid on Vemork. It wrote to Combined Operations HQ; the reply it received warned against using gliders to bring in the raiding force as finding the landing place among lakes and valleys that all looked the same would be difficult; they suggested using sabotage instead.

Generaloberst Nikolaus von Falkenhorst was the supreme military commander of the German armed forces in Norway from 1940 to 1944. He was the ground commander of the invasion of Norway in April 1940. (Photo by Klaus Niermann/ ullstein bild via Getty Images)

In May 1942 Josef Terboven, the Reich Commissar for Norway, visited Vemork and by June 286lb of heavy water per month was being achieved. In June Diebner met with the armaments chiefs of the different armed services to discuss the military utilisation of their research. Heisenberg reported the progress of the atom bomb. German scientists had split U-235 in a laboratory, but the generals did not think that a bomb was achievable in this war and instead wanted rockets that offered immediate rewards. Army Ordnance would still finance research on the atom bomb, but would not command the programme. In August an undeterred Diebner visited Vemork and Brun reported that Diebner told him he had received 3,306lb of heavy water and needed 6,613lb per year for his uranium machine. There were plans to build hydroelectric plants at Såheim and Notodden to produce in total 11,023lb of heavy water per year.

In July 1942 the War Cabinet ordered Combined Operations Command to destroy the Vemork plant. Col R. Neville was the planner at Combined Operations HQ. In August there was a meeting with Tronstad, Neville and the Directorate of Atomic Alloys in attendance to discuss options. They considered using men already at Vemork to destroy the plant; deploying other agents to infiltrate the plant; sending in an SOE sabotage party; sending in a Combined Operations force of 25–50 men using planes from Coastal Command that could land on a lake; sending in a Combined Operations force that would not return; and RAF bombing. Tronstad suggested using Brun; however, failure would reveal him to the Gestapo.

The military campaign to occupy Norway was short. All weapons held by Norwegian soldiers needed to be handed in. Most farmers and hunters had weapons too and if any were found the owner could be sent to an internment camp. (Photo by Keystone/ Getty Images)



Josef Terboven (right) was the Reichskommissar for Norway appointed by the Germans in April 1940. He had joined the Nazi Party in the early 1920s and in 1928 had risen to become the regional party leader in Essen. In 1935 he was the governor of the Rhineland. In Norway he had only supervisory authority over Quisling's government. He did not control the military, but was responsible for 800 personnel of the secret police. He was criticised by Joseph Goebbels, the Reich Minister of Propaganda, for using bullying tactics with the Norwegian populace. In Trondheim he introduced martial law in 1942. He established internment camps and would order the execution of those held there in retribution for attacks on German soldiers. (Bundesarchiv Bild 121-1383 Foto: o.Ang)

Attack from within was ruled out because of the technical training required and lack of explosives. SOE thought infiltrating other agents into the plant was difficult because this required the help of a person on the inside and he could be revealed; they thought a small team of SOE soldiers could attack the plant, but a larger force would be preferable. Tronstad also suggested the heavy water could be stolen. Wilson favoured using SOE saboteurs rather than the commandos, but Neville was unsure, as he thought defences were better than reported. Later meetings decided to plan a joint SOE/Combined Operation. Adm Lord Louis Mountbatten would have the final decision on whether the operation would be launched. Tronstad wanted to go on the operation, but the head of SOE, MajGen Gubbins, refused.

SOE Norway Section had decided to infiltrate a small reconnaissance group onto the Hardanger Plateau in south-west Norway, 20 miles west-north-west of the Norsk plant in Vemork under the codename Operation *Grouse*, whether or not a plan to attack the plant was agreed. It had a long-term objective to organise and train resistance groups to attack infrastructure. The men came from the Norwegian Special Forces and were skiers and survivalists. SOE had trained them to be demolition experts and marksmen. They were also taught breaking and entering. SubLt Jens-Anton Poulsson had already prepared to operate in Telemark to organise resistance networks and sabotage railways and he was chosen to lead the team. He attended Beaulieu in April 1942 for specialist training in espionage that included how to develop a cover and recruit agents, how to establish a covert HQ, how to combat the counter-intelligence threat that included wireless interception and interrogation, and how to conduct surveillance and leave concealed messages. He was tasked with landing near Vemork to be ready to prepare lights to lead bombers to the Vemork plant and destroy the ferries of Lake Tinnsjø. His team included Arne Kjelstrup, a short, broad plumber,

JULY 1942

Combined Operations is ordered to destroy Vemork

The Norwegian resistance movement Milorg (military organisation) was formed in May 1941 and was integrated with the Norwegian government in exile in London, but only at the end of 1942 would SOE coordinate fully with Milorg. Initially they had a low profile because of the fear of retribution, but as the war progressed permanent training bases were established and by May 1945 there were 40,000 resistance fighters. The Rjukan Milorg cell commanded by Olav Skogen would prove helpful to SOE in planning the Vemork raid; Skogen was arrested late in 1942, but his interrogators failed to obtain details of his organisation. Here, a group of Milorg is addressed by a commander equipped with a Sten gun. (Photo by ullstein bild/ ullstein bild via Getty Images)

Knut Haugland, a slim boyish-looking radio operator from Rjukan, and Claus Helberg. Helberg, a childhood friend of Poulsson, had replaced Knut Haukelid; the latter had shot himself in the foot during training. Skinnarland would prepare for their arrival but the summer sun prevented their departure.

Following the Lofoten Island raids in late 1941, the German garrison in Norway had increased to 250,000 and resistance fighters and civilians were being murdered. Tronstad's wife was interrogated. SS Obergruppenführer Wilhelm Rediess, Chief of Police and Schutzstaffel (SS) in Norway, was in charge of security. He would make operating in Norway fraught with difficulty, but SOE would be operating in a region where few German soldiers were to be found.

The Germans were capable of conducting sweeps of local areas to search for resistance fighters or those that might be hiding them or their equipment. With 250,000 soldiers in Norway they could use trains or motorised vehicles to reach populated locals, but making forays in winter into areas like the Hardanger Plateau was beyond them. Hiding out on the plateau that was within reach of Vemork without relying on the local population enabled SOE to avoid these searches. (Photo by ullstein bild/ ullstein bild via Getty Images)

INITIAL STRATEGY

Infiltration

On 1 October 1942 Generaloberst Nikolaus von Falkenhorst, the German commander in Norway, visited Vemork. A raid by SOE on the power plant at Glomfjord in late September had destroyed two pipelines there and the aluminium works. Von Falkenhorst mentioned to the guard force at Vemork how impressive British commandos were and personally demonstrated their tactics when assaulting guards. He told commanders he did not have enough guards to garrison the plant (he thought 100 would be needed) but recommended floodlights, guard patrols, barracks, mines, fences and barbed wire. Most of the security provisions were focussed on the rear of the plant; with the raid on Glomfjord suggesting the water supply would be targeted. Von Falkenhorst recommended using barbed wire near the pipelines that was electrified and connected to an alarm, especially as the front of the plant was considered unassailable. Searchlights were installed on the roof of the electrolysis plant and a machine gun hidden in a hut near the entrance. New regulations and travel permits were introduced. Brun sent news to Tronstad that a garrison of 100 men were based in Rjukan, Møs Dam and Vemork.

The Norwegian recruits chosen to be members of SOE that von Falkenhorst was worried about were carefully chosen; during the interview process they were closely monitored to check whether they were troublemakers or indiscreet. They initially attended a three-week course in physical fitness,

LtCol J. Wilson had devised SOE training before assuming command of the Norwegian section of SOE in January 1942. Before the war he had worked for the Boy Scouts. He had also served in the Indian police force (1908–22) and was a specialist in counter-espionage and guerrilla warfare; he would stay with local tribes and immerse himself in their culture. SOE recruits would look to him for guidance. (Norges Hjemmefrontmuseet) map reading and weapons training. They were then sent to the Scottish Highlands and could attend specialist Special Training Schools (STS). SOE taught rappelling and rope work, how to fire all weapons instinctively, how to clear buildings, how to plant demolitions, how to orientate without maps, how to camouflage themselves when moving through various terrain types. They were given targets, they would plan their routes in and out, divide their force into covering and demolition teams, and use real weapons and explosives. They would be captured and interrogated. The next phase was at Beaulieu, where they were taught how to recruit and operate agents.

All of *Grouse* had gone through parachute training that had included jumping from a balloon in the dark. Helberg described how this was different from jumping from a plane:

> When you jump from a plane, the wind takes you so fast horizontally that your chute opens right away, that is in about a second and a half. But when you jump from a balloon, you fall straight down about 250 feet before anything happens. It takes about five seconds for the chute to open, and since you can't see how close you are to earth, you keep wondering, will I hit before it opens? Everything is quiet; there is no horizontal wind, no roar from the plane's engine. It's dark, and as you fall you get this terrifying sense of the increasing velocity of your descent from the sound of the air rushing through your clothing. Then, when your chute finally does open, you still can't see the ground. (Quoted in Gallagher, pp.36–37)

Poulsson was told about the plan to attack the plant with commandos; his team would make a reconnaissance to reconnoitre the landing site that was already identified as suitable for gliders – the Skoland Marshes; he was not to tell the others that the heavy water plant was the objective until they had landed. Wilson told him London could be destroyed if he was not successful, but Poulsson did not believe him. While in London they went shopping for winter gear including clothing and tents. A firm made them bespoke sleeping bags that had a water-resistant inner layer made of compartments that were stitched separately and filled with down, and an outer layer that was capable of shedding water. Rucksacks, gloves and boots were supplied by the Norwegian Army Supply Workshop in Dumfries.

From September *Grouse* waited for a moonlit night and good flying weather. Twice that month they boarded a Halifax bomber and headed off. On the first flight, on 27 September, Helberg described the engines failing and just making it back. On the second flight the next day there were reports that heavy fog would prevent a return landing and the flight was cancelled. On 18 October 1942 *Grouse* was at last given the go-ahead, despite Wilson wanting to cancel the operation because of reports of increased enemy

Norwegian recruits to SOE on completion of training were sent to STS 26, at Drumintol and Glenmore shooting lodges near Aviemore, the home of the Norwegian company, set among rugged terrain that closely resembled their native land, where Wilson spoke about the sabotage operations the company would carry out. Tronstad (far right) is seen training there with other men from the Norwegian SOE company, including Poulsson and Kjelstrup. Between 20 and 25 Norwegian recruits were trained per month. (Norsk Industriabeidermuseum. Foto: Kårvand, Ingelinn)

18 OCTOBER 1942

***Grouse* team parachutes onto the Hardanger Plateau; begins reconnaissance**

activity, and the men landed in the middle of a snowstorm on the plateau. They had jumped on a clear night from 1,000ft. Poulsson was first and Helberg last; eight containers landed with them. Helberg recalled:

> The wind tore and pulled at me as I fell, and the parachute was drawn open by the string. Suddenly the parachute filled with air and stiffened; there was a violent jerk as it opened wide above me. Two seconds and it was all over. The most important thing had happened. The parachute had opened without a hitch. I found myself floating slowly down toward the ground, with all our equipment, twelve huge containers, floating down through the moonlight behind us, and the plane disappearing westwards.' (Quoted in Gallagher, p.41)

They landed safely, as did their equipment. Poulsson told them their role was to find a place close to Vemork for gliders to land in order that the soldiers they were bringing in could quickly attack the heavy water plant. Helberg and Poulsson agreed that the Skoland Marshes, 4 miles from the Møs Dam and near a road that passed close to Vemork, was an ideal site. They had four weeks to make the arrangements as the gliders were due during the next full moon. They had landed east of Fjarefit in the Songdalen, 6.2 miles west of where they were meant to land, on marshes east of Ugleflott; they were 30 miles from Vemork.

The men took two days to gather in their supplies. The skis were only found in the last container and they had to spend their first night outside in sleeping bags. They had to travel to the Skoland Marshes, but because the paraffin for their cookers was lost they were forced to travel through the valley rather than over the plateau in order to find firewood, pulling 650lb of equipment, and only had rations for 30 days. They were told to meet no one and could not count on local support. Half the equipment remained at the landing site to assist them on their return, but each of the soldiers had to carry two loads of 65lb and that meant covering three times the distance to bring all the supplies along.

Progress along the riverbanks was slow as the ground was covered with wet snow that clung to their skis. The surface water had not frozen and on some days only a few miles were made. They used cabins to sleep in, but rations were meagre and they were suffering badly. On 30 October they reached a cabin at Reinar, 7 miles south of Skoland Marshes. There Haugland stayed to work his radio. Poulsson and Kjelstrup pressed on to inspect the landing site, and Helberg skied back to an unoccupied summer farm to look for food. Poulsson described some of the difficulties, telling how he 'fell through the ice while crossing a river. This was the second time. Next day we tried to cross another river, but found no ice and returned, tired out, to the cabin, where Haugland told us that, at the moment he succeeded in making contact with London, his storage battery had run out. Our job depended upon our being able to find a new storage battery, for without one we could not contact London'. (Quoted in Gallagher, p.47) The battery was twice as heavy as the usual Ford car battery that Haugland had asked to be supplied with and was stamped 'Made in England'. The hand generators were not able to cope with a large battery and burned out. If they could not get their radio working, Wilson and Tronstad would assume they had perished. Helberg returned with food and they were able to push on to a cabin at Grasfjell on Lake Sand, east of the Møs Dam and 5 miles from the proposed landing site at Skoland. They arrived on 5 November and the following day Helberg skied over to see Torstein Skinnarland, keeper of the dam and a friend of Helberg.

On 22 October, in his office in the plant, Brun received a telephone call from a resistance operative, Fredrik Bachke. He obtained a visitor's pass for him and was told by Bachke to leave for London. Tronstad did not want Brun caught up in the attack on the plant. He gathered plans of the plant and anything else that may be useful to Allied intelligence, including some heavy water samples. He departed with his wife two days later and was smuggled over the Swedish border.

On 9 November, with a battery supplied by Torstein, Haugland made contact with London and reported that *Grouse* had arrived safely. He had built an antenna using fishing rods connected with copper wire. He sent short messages in code that were difficult to intercept. On 12 November Haugland told London that the navigation aid called Eureka had been tested successfully and that a 700yds long landing place without trees or stones beside a road by Skoland log cabin, 3 miles from Møs Dam, could not be

Many Norwegians found the fieldcraft training in Scotland familiar as the terrain closely resembled Norway; although not as cold in temperature, Norwegian recruits thought the wet conditions made the climate feel cold. *Grouse* were trained to parachute and their role would be to guide in a larger raiding force to Vemork, sent by glider from Britain. (Photo by European/FPG/Getty Images) seen by the Germans. Depth of snow was reported as 1ft on the landing area and he advised the commandos to bring snowshoes. Bicycles would be useless and the assault would not occur during the night of the landing. This would mean that the gliders would have to be camouflaged, but for this the wings, fin and tail plane would have to be removed by soldiers and there was little time to train them. If snow was on the ground then any trampling about would be noticed from the air. On 17 November the weather was improving and Haugland reported to London: 'Lake covered with ice and partly covered with snow. Larger lakes are ice free. Last three nights sky absolutely clear with moonlight'. (Quoted in Gallagher, p.53)

Combined Operations had put together a platoon of 34 commando engineers that were waiting to land. Royal Engineers would form the assault force and 25 were from 9th Field Company, RE (Airborne) and ten were from 261st Field Company, RE (Airborne). Lt A. C. Allen from 261st Field Company was in charge and 2Lt M. D. Green from 9th Field Company was his deputy. LtCol M. C. Henniker was the force commander and was in charge of training and the attack plan. Aircraft from 38th Squadron would be supplied to tow them.

The raid would be mounted from Skitten, a satellite airfield for RAF Wick, in Scotland. If something went wrong with one of the gliders the soldiers in the other would be capable of mounting the operation on their own. The first glider party would wait 30 minutes for the arrival of the second; if it did not arrive two men would remain in case they arrived later. Gliders were capable of landing on hard frozen ground that could cause high casualties to parachutists. If the raid could not happen in November then ski-trained troops would be needed.

Henniker's men were not told the target, rather they were told the target was behind enemy lines and the operation was dangerous; those with personal reasons could opt out and return to their unit with no questions asked. A deception plan for the glider operation was worked out to cover the training, movements and demands for stores that involved a competition between US and British glider troops called the Washington Cup. The competition involved a long approach, a demolition task and then an endurance test. The competition started on 19 October and Henniker had made a show of addressing his men as part of the subterfuge plan. The men took part in gruelling marches that included map reading and the use of compasses for navigation.

They were issued with warm weather clothing and special packs that could carry 80lb of equipment. White clothing was to be worn over battledress in the event of snow. They visited a

Sgt Arne Kjelstrup was also from Rjukan but had moved away from the town at an early age. He had made frequent visits and was familiar with the area, however. He was wounded during the invasion and only survived because the bullet that hit him was stopped by equipment he was carrying. He had escaped to Sweden; he made the long trip with Poulsson to London. After the raid he returned to Norway in 1944 with the then Maj Tronstad to participate on Operation *Sunshine*, which was intended to prevent the Germans destroying Norwegian heavy industry at the end of the war. (Norges Hjemmefrontmuseet)

The intended role of *Grouse* was to reconnoitre the layout of the plant, find out what resistance would be expected, and work out the best approach routes. They were also to provide weather reports and operate Eureka, a navigational aid designed to guide aircraft towing gliders in on the night of the operation, light beacons on the landing sight and guide the soldiers to Vemork. The area was high and inhospitable and in winter attracted few visitors; their endurance would be put to the test. Here Tronstad is seen skiing in southern Norway in 1944/45. (Norsk Industriabeidermuseum. Foto: Kårvand, Ingelinn)

hydroelectric dam in Scotland. They were shown how to lay the explosives to cause the most damage and carried out practice raids on a replica. They were taught close combat and how to clear a street by having cardboard targets appear at windows. They practised navigating through rugged terrain using a map and compass. At Bulford they were trained on the use of snowshoes at night. Silk maps, button compasses and Norwegian money were issued, sewn into their uniforms. They were told the essence of the operation was speed; if a soldier fell out he was to be left behind. The plan presumed those that were wounded and captured would be treated as prisoners of war by the Germans.

If the glider landed in the wrong location then the officer in charge would decide whether the attack was still feasible; if it were not, then the officer would decide whether an escape to Sweden could be made. The officer needed to assess the situation. The issues of what to do with any wounded, how to guarantee the glider would not be discovered, and how to use the local population as scouts would all need his attention. He would not know whether the other glider had landed safely and whether the attack was being carried out by them.

Following the raid Henniker had wanted the men to fight as a group, but MI9, the specialists in escape and evasion within military intelligence, told him this was impractical; the men would escape in pairs on divergent routes to hinder a pursuit. Bigger groups would look suspicious. Civilian clothes that looked Norwegian were provided, to be worn beneath their battledress. No weapons were to be carried or used during the escape and they should be dispensed with no less than 5 miles from the plant. They were told if they were caught carrying weapons or military information while in civilian clothes they could be condemned as spies. The routes into Sweden they would use were investigated. A long 250-mile detour north that would not be guarded as heavily was the preferred route for those less sure of their disguise, but the Glommen River would have to be crossed and the local population was thought to be less reliable. They were told, if using the shorter southern route, to walk by day and use local barns to sleep in, and if using the northern route, to walk at night because of the risk of death from the cold. They were told to only approach isolated farmhouses; if the occupants were traitors their chances of escape were better. They were to say at the Swedish border that they had escaped from the Germans; escaped prisoners that reached a neutral country had the right to be repatriated, whereas combatants that entered a neutral country without being in enemy hands were interned.

Henniker was reticent about the operation's chances of success. He thought RAF navigation was not up to the job. GpCapt Cooper, in charge of the air component, was also worried and reported his concerns to Combined Operations: finding the landing area depended on Eureka. The Eureka device that *Grouse* was operating was designed to send a signal to the aircraft; the signal would be detected by the equipment on board the plane and the range and position of the Eureka device could be worked out based on the timings and direction of the signal. The device had to be installed on the aircraft by 38th Wing ground crew. They had ten hours with Eureka on the Halifax and results were, on the whole, positive, but Cooper described the training the crews had had with the device as limited. The pilots would have to depend on Eureka if the Skoland Marshes were not observed. The maps the crews had of the area showed different shapes for lakes and relying on these would court disaster. Wilson was alarmed when he heard that the crews had not practised towing gliders in high terrain. Another unknown was the effect of the cold. A telephone cable that enabled the towing aircraft to speak with the glider pilots was woven into the hemp rope that towed the glider, but there was a danger that the hemp rope could freeze and, in the worst case, break.

The initial plan included an option to insert the soldiers by two Catalina flying boats. SqnLdr Ashstead of Coastal Command agreed to look at the feasibility of flying boats on 13 October 1942. The plan was to land on Lake Møs; the attack would start the next day and the men would retreat 6.2 miles west, where a flying boat would meet them. The Chief Air Planner thought this unfeasible; they could be spotted by the workers on the dam, the aircraft made a big target for interceptors, and the lakes would soon freeze. Lakes, though, would not be sufficiently frozen to allow a heavily laden glider to land on them and instead the raiding party would land on Skoland Marshes, to the south end of Lake Møs, seen here with the dam in the distance. (Norsk Industriabeidermuseum. Foto: Andreassen, Anders)

Combined Operations HQ decided that gliders would be used to ensure all the equipment arrived. Wilson described Norway as the least suitable place to use them. SOE had tried to dissuade the War Cabinet from using the engineers, highlighting the dangers of inserting a glider force onto the plateau in winter. The journey from Scotland by Horsa glider, seen here, towed by Halifax bombers across the North Sea and on to the plateau was indeed perilous. The Horsa was made out of plywood, and when the tow rope was released the pilot would have to conduct a controlled crash near Lake Møs. They would then march to Vemork, cross the suspension bridge and storm the facility, destroying the stockpiles and facility. (Photo by Topical Press Agency/Getty Images)

In spite of the difficulties, the decision to destroy the plant completely required the size of force contemplated and a parachute landing was ruled out; this would risk detection as the aircraft would have to overfly Rjukan on their approach in, the force would be dispersed on landing and some soldiers might be wounded. 300lb of TNT were required and only gliders would be able to bring in this size of explosive. The use of an SOE team for the raid itself was dismissed because it would not be able to carry the explosives needed to destroy the whole plant. Reports were received that the Germans had test-fired a V2 rocket and the danger was that a nuclear warhead on such a device would be capable of destroying London. There were also reports that the stocks of heavy water were to be moved to Germany.

Other reports, this time about the defences, led some in Combined Operations to suggest a force of 250–300 men was needed, but this would probably mean the operation could only occur in January and escape would not be an option. Intelligence was received that there were 100 soldiers in Rjukan with 200 more about to arrive; 35 men were in Vaer School at Vemork; at Mosvann there were 20 men; more were about to arrive at Skarsfoss Dam, 3 miles from the target, but on the route the engineers would need to use. In October, intelligence suggested that engineers had arrived to lay mines. At the plant the pen stocks were said to be protected by barbed wire, wire netting and electrical alarm wires. The raiders would need to push through any resistance, as surprise was considered likely.

Mountbatten pressed for urgency and Churchill approved the operation. On 2 November the engineers met with Tronstad at SOE's sabotage school; they were shown aerial photographs and a model of the heavy water concentration cells. A model of the surrounding area including the valley was also seen. On 15 November, at a meeting at Norwegian SOE HQ, Henniker decided that two *Grouse* men would lead the glider soldiers to Vemork. The raiders would hold the bridge and prevent reinforcements from entering the plant.

Wilson and Tronstad objected to the plan. They stated that the terrain was highly unfavourable to glider operations. Landing areas were few and the broken nature of the countryside – comprising hills, bogs, lakes and boulders – made landing a glider dangerous. The journey was 400 miles and would be the longest tried by towed glider. Weather on the Hardanger Plateau could not be guaranteed and low cloud cover might obscure the landing area or the moon, limiting night visibility. Bicycles would be useless if there was heavy snow. The party would have to escape through 400 miles of inhospitable terrain to Sweden. Combined Operations overruled the two SOE's objections. Tronstad suggested saving generators in order to keep the hydrogen plant working and Rjukan viable as a community, which was agreed to.

On 16 November two Halifax aircraft arrived at Skitten along with the gliders. Green was injured; when he was cleaning his revolver an explosion occurred, damaging his finger. He was replaced by 2Lt Methven. Driver Sydney Brittain was also missing as he had sprained his foot. Cooper arrived with a third Halifax the next day. On 18 November Henniker participated in a training sortie that would overfly the landing site to familiarise the pilots of the bombers with the approach they would need to use. An engine failed and the bomber had to return to base before Norway was reached. The other Halifax piloted by Cooper failed to detect the landing site. On 19 November a Norwegian meteorologist from Combined Operations, LtCol Peterssen, reported westerly currents over Scotland and the northern part of the North Sea; he warned against taking off that day, instead waiting until Arctic winds arrived two days later. The meteorologist at the airfield had no doubts and with this advice the decision to launch was given. The forecast in the early afternoon was made without the usual meteorological flight from Wick, because the aircraft was unserviceable; Peterssen complained there was insufficient data.

On 19 November the towing aircraft and their gliders set off at 1745 and 1800 BST and *Grouse* was informed by radio of their departure. The weather briefing had said the landing area would have clear skies and a full moon. Haugland and Kjelstrup had prepared the Eureka, Poulsson and Helberg the landing site by placing red lights 100 yards apart in an L shape. Poulsson would be at the corner with a white light. The Halifax would send a shortwave radio signal to the Eureka, Haugland would hear a tone and signal to the aircraft; the navigator would roughly know the distance and whereabouts of the landing area. On the landing site the clouds were starting to obscure the moon and a north-west wind increased. At 2040 GMT Haugland heard a tone and the lights were lit. The clouds might have obscured them. Aircraft engine noise was heard but passed overhead; then again a tone from the east that also passed. At 2230 GMT *Grouse* departed for their hut. No landings had occurred.

19 NOVEMBER 1942

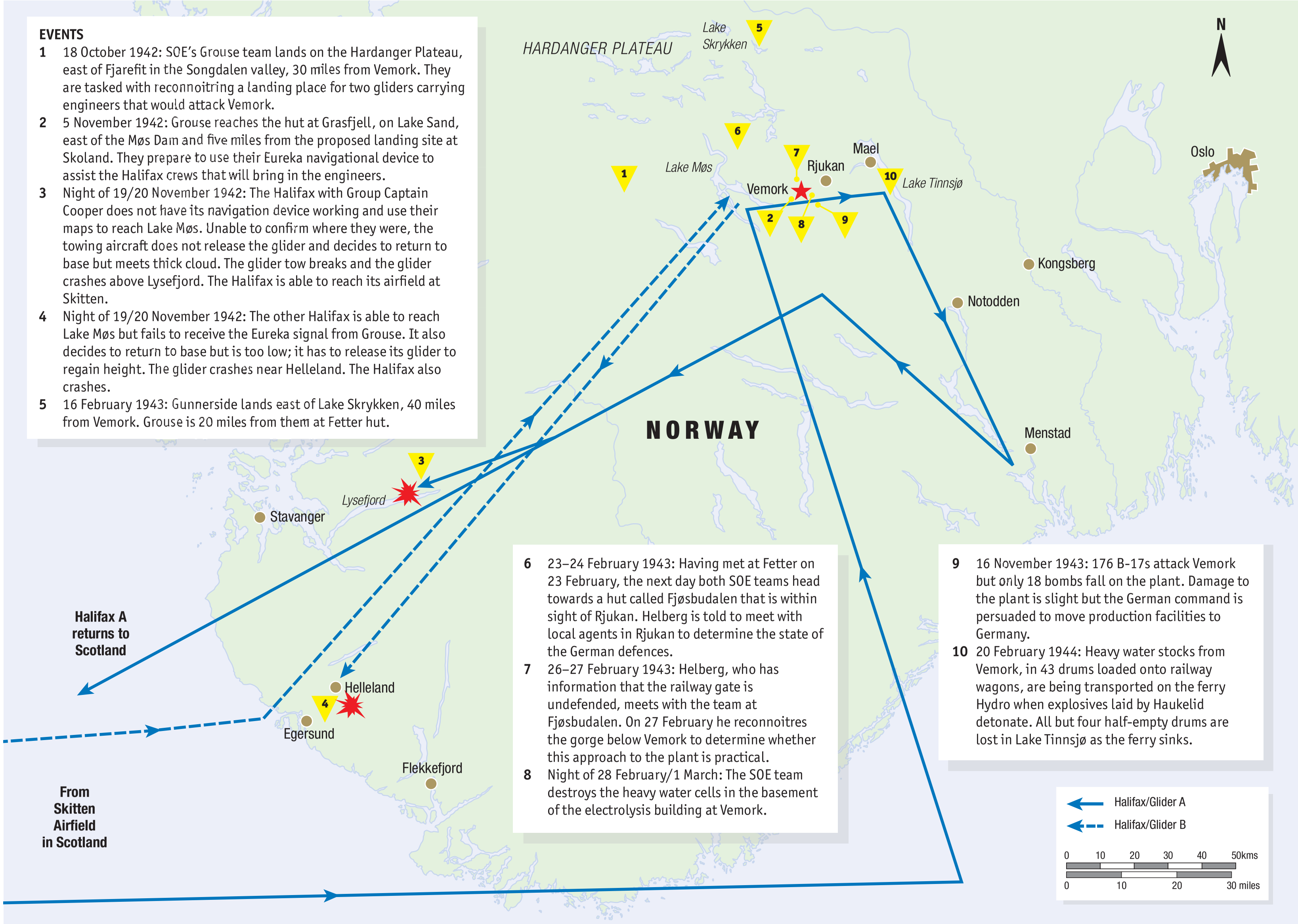
A glider-borne insertion attempt fails, with two gliders and one Halifax crashing

On the first Halifax, piloted by SqnLdr A. Wilkinson and with Cooper on board, the generator overheated, the wiring burned out and the navigational system was not working; Eureka would be useless. Also, the telephone cable running through the towing cable failed following take-off, so they had no communication other than Morse. The second Halifax, piloted by FltLt A. Parkinson (RCAF) that did have its navigational aid working, flew low below the cloud and reached land. The crew failed to locate the Eureka signal and, low on fuel, decided to return to base. The Halifax was too low and only cleared the first mountain by releasing the glider north-east of Helleland, close to the town of Egersund. It tried to search for the glider but was too low. The next mountain could not be cleared and the aircraft crashed, killing all the crew. A furrow more than 700 yards long was ploughed by the aircraft.

The glider towed by Parkinson descended into a thickly wooded valley; the crash was partially controlled and three men died, including the pilots, Pilot Officer Davies and Sgt Fraser. Allen survived and decided to send two men to seek assistance from the locals at a farm called Hovland Farm in Helleland. At 0215hrs on the morning of 20 November, Trond Hovland heard a hammering on his door and let them in. They told him a plane had crashed 2 miles to the north. There were showers of rain and hail outside and it was severely cold. Trond's father, Sheriff Theodor Hovland, was in the farmhouse with his son; he agreed to call the local doctor in Egersund, but said he would have to inform the local German commander as the call went through the operator. They assumed the British would be taken as prisoners of war. The soldiers agreed. Norwegians from a work camp that was close by said they would help recover the wounded.

A German patrol from the garrison at Slettebo arrived at 0530hrs and a soldier that had landed in the glider led them to the crash site. The

Whitley bombers with long-range fuel tanks were capable of reaching Vemork, but were unable to tow gliders that distance without risking engine failure; instead the larger Halifax would be used. The pilots of the Halifax had not practised with the planes they were flying; instead they had used Whitley bombers and had not practised much with the glider pilots either. Here, a Halifax is seen towing a Horsa glider. (Photo by Charles E. Brown/Royal Air Force Museum/Getty Images)



HARDANGER PLATEAU
Lake Skrykken
Lake Møs
Vemork
Rjukan
Mael
Lake Tinnsjø
Oslo
N
Kongsberg
Notodden
Menstad
NORWAY
Lysefjord
Stavanger
Helleland
Egersund
Flekkefjord
Halifax A returns to Scotland
From Skitten Airfield in Scotland
1
2
3
4
5
6
7
8
9
10
Halifax/Glider A
Halifax/Glider B
0 10 20 30 40 50kms
0 10 20 30 miles

EVENTS

1 18 October 1942: SOE's Grouse team lands on the Hardanger Plateau, east of Fjarefit in the Songdalen valley, 30 miles from Vemork. They are tasked with reconnoitring a landing place for two gliders carrying engineers that would attack Vemork.

2 5 November 1942: Grouse reaches the hut at Grasfjell, on Lake Sand, east of the Møs Dam and five miles from the proposed landing site at Skoland. They prepare to use their Eureka navigational device to assist the Halifax crews that will bring in the engineers.

3 Night of 19/20 November 1942: The Halifax with Group Captain Cooper does not have its navigation device working and use their maps to reach Lake Møs. Unable to confirm where they were, the towing aircraft does not release the glider and decides to return to base but meets thick cloud. The glider tow breaks and the glider crashes above Lysefjord. The Halifax is able to reach its airfield at Skitten.

4 Night of 19/20 November 1942: The other Halifax is able to reach Lake Møs but fails to receive the Eureka signal from Grouse. It also decides to return to base but is too low; it has to release its glider to regain height. The glider crashes near Helleland. The Halifax also crashes.

5 16 February 1943: Gunnerside lands east of Lake Skrykken, 40 miles from Vemork. Grouse is 20 miles from them at Fetter hut.

6 23–24 February 1943: Having met at Fetter on 23 February, the next day both SOE teams head towards a hut called Fjøsbudalen that is within sight of Rjukan. Helberg is told to meet with local agents in Rjukan to determine the state of the German defences.

7 26–27 February 1943: Helberg, who has information that the railway gate is undefended, meets with the team at Fjøsbudalen. On 27 February he reconnoitres the gorge below Vemork to determine whether this approach to the plant is practical.

8 Night of 28 February/1 March: The SOE team destroys the heavy water cells in the basement of the electrolysis building at Vemork.

9 16 November 1943: 176 B-17s attack Vemork but only 18 bombs fall on the plant. Damage to the plant is slight but the German command is persuaded to move production facilities to Germany.

10 20 February 1944: Heavy water stocks from Vemork, in 43 drums loaded onto railway wagons, are being transported on the ferry Hydro when explosives laid by Haukelid detonate. All but four half-empty drums are lost in Lake Tinnsjø as the ferry sinks.

Norwegians were also following and when the Germans fell behind they pushed ahead to reach the crash site first; they told the survivors they had time to escape before the soldiers arrived, but Allen decided to surrender without a fight. Three soldiers were severely wounded and could not walk. While waiting for the German patrol they burned anything thought to be incriminating. Trond had to return to Hovland Farm at 0700hrs to obtain stretchers. By 1030hrs all the British soldiers were in his farm. A German doctor arrived and gave morphine injections to the wounded.

On 18 October the notorious Commando Order had been issued, which stated that commandos were to be given no quarter whether they did or did not have weapons; attempts to surrender were to be ignored. The Wehrmacht by this order had to hand the glider soldiers over to the Sicherheitsdienst (SD) and not hold them in military custody. The order stipulated that commandos were to be shot immediately following interrogation. If this order was not adhered to then this would result in court martial for those responsible. The British soldiers were brought to Slettebo where Hauptman Schrottberger asked Oberst Probst in Stavanger what he should do with them. SS-Untersturmführer Otto Petersen, the local Gestapo commander in Stavanger, went to Slettebo and demanded Schrottberger hand them over, but the captain refused. Still the decision was taken that the survivors of the glider that crashed in Hovland would be shot on the day of their arrival at Slettebo. SS-Obergruppenführer Wilhelm Rediess sent a message to Berlin saying shooting them was unfortunate. Rediess and Reichskomissar Terboven were annoyed. Von Falkenhorst stipulated that interrogations would occur and only then would commandos be shot.

The fate of the other glider piloted by Sgt M. Strathdee and Sgt P. Doig, and towed by Wilkinson, was worse; they had gained altitude through holes in the clouds and at 10,000ft reached Norway. Wilkinson started to follow a line of lakes towards the landing area; however, navigation by looking at landmarks became too hard and they were lost. The shore was reached; they returned towards the target, but with the moonlight emanating from behind the fuselage rather than in front of the cabin, map reading was difficult. Wilkinson did not release the glider, because he was still searching for identifiable lakes to show they were in the right place; the signal from the

At over 3,000ft above sea level, the Hardanger is 3,500 square miles of uninhabited wilderness; a confusing landscape of rock, lakes, marshes and rivers. The only signs of habitation are the few huts that hunters use, often situated by the lake shore. In winter covered by snow and ice, there are some birch trees on the lower slopes but nothing on the higher ground. The temperature could plunge to minus 30 degrees Celsius. Snowstorms could reduce visibility to a few feet. There were no German soldiers that garrisoned the area; they preferred not to stay the night on the plateau and would always ensure they could leave the same day. (Norsk Industriabeidermuseum. Foto: Kårvand, Ingelinn)

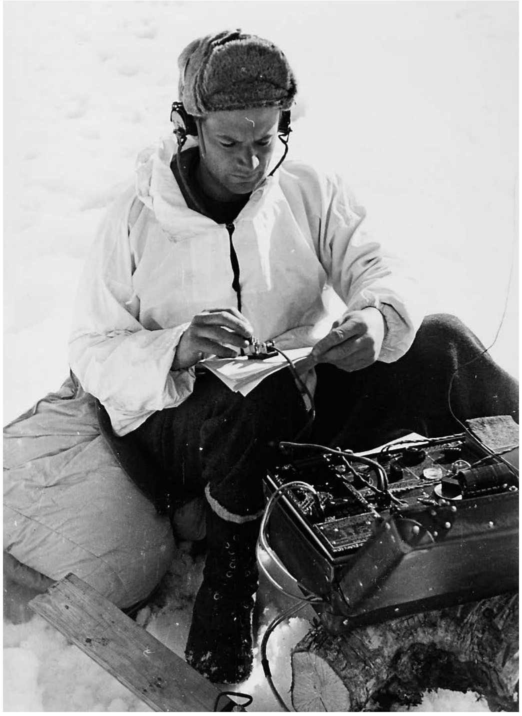
Eureka could not be received and clouds might have obscured the landing lights. Cooper decided to return to base, as his fuel was low. There was not enough fuel to pull the glider to Wick, so he decided to release the tow in the North Sea when he was 31 miles east of Scotland; the glider pilots would have to ditch.

The cloud was thickening. They were flying at 9,000ft but the clouds extended to 10,000ft and to avoid them they climbed to 12,000ft, but at this altitude the wings began to ice and the aircraft lost height involuntarily. In the clouds the situation worsened and Cooper told Wilkinson to get down below the freezing level to melt the ice. At 7,000ft they met a thick layer of cloud and turbulence increased. Eventually the tow line broke and the glider swerved down onto the slopes overlooking Lysefjord. In the glider equipment was flying everywhere as a violent spin could not be controlled by the pilots. At 2355hrs a radio message to Wick stated that the glider had been released into the sea. When the tow returned to Wick a careful check of courses and times proved that the glider had in fact been released over land.

In the glider eight men died, including the two pilots; only five men were uninjured and in the morning two of them went to a local farm. The glider had crashed in Fylgjesdalen, a remote area where Thorvald Fylgjesdalen lived with his family. Jonas Haaheller also lived close by, in a farm on the north side of Lysefjord. When Thorvald observed three men approaching his house, wearing uniforms and badly bruised, he led them down to the farm owned by Jonas by the lake. Jonas phoned the law officer, a lady called Hjordis Espedal, at 0130hrs. She reported the matter to Rogland police HQ. In the late afternoon a doctor reached Jonas' farm. The soldiers told them their ordeal in the glider and that they wanted to reach Sweden. They said that seven men were killed instantly. The Norwegians could not help them escape because the crashed glider was evidence of a raiding party and there was a risk of reprisals. In addition, some were wounded and needed medical treatment. The Norwegians did, however, agree to help them to destroy evidence.

Inspector Ravn Tollefsen arrived from Rogland police HQ; he started out for the crash site with Lief Espedal. Others were summoned to help. That night they reached Thorvald's farm and a soldier led them to the crash site. He told them why they had landed. They discovered the glider on a hillside, dotted with small birches and boulders. Food, clothing and equipment lay everywhere. A wounded soldier had crawled from the wreck to find wood for a splint but had died of exposure and loss of blood. Three soldiers were alive, all wounded, and they were taken to Thorvald's farm in the early morning, when other Norwegians arrived. Tollefsen and Espedal went to burn the site before the Germans got there. The site was remote and they had plenty of time. Between 40 and 50 Germans, including Wehrmacht soldiers and SS, had set out from Stavanger and most of them went to the farm. The Gestapo phoned the farm to tell the local constable that his life would be forfeit if the prisoners escaped. They surrounded the farm and moved in.

SS-Obersturmbannführer Heinrich Fehlis, the security chief in Oslo responsible for the safe arrival of heavy water shipments arriving there,



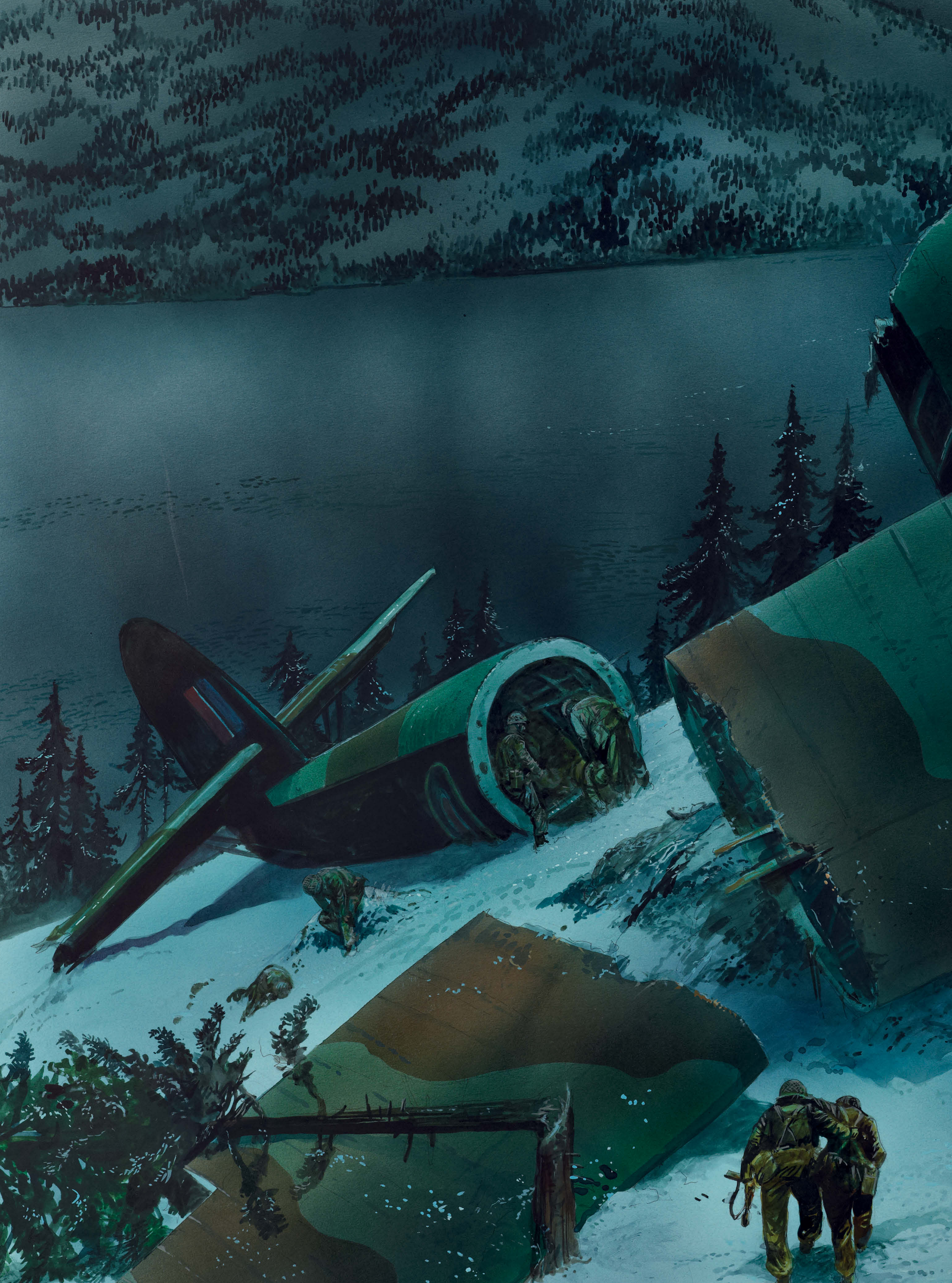
Maintaining communication with London via coded Morse was vital for passing instructions to the SOE team. Here, Helberg is seen as the radio operator when Tronstad was sent to Norway in 1944. (Norsk Industriabeidermuseum. Foto: Kårvand, Ingelinn)

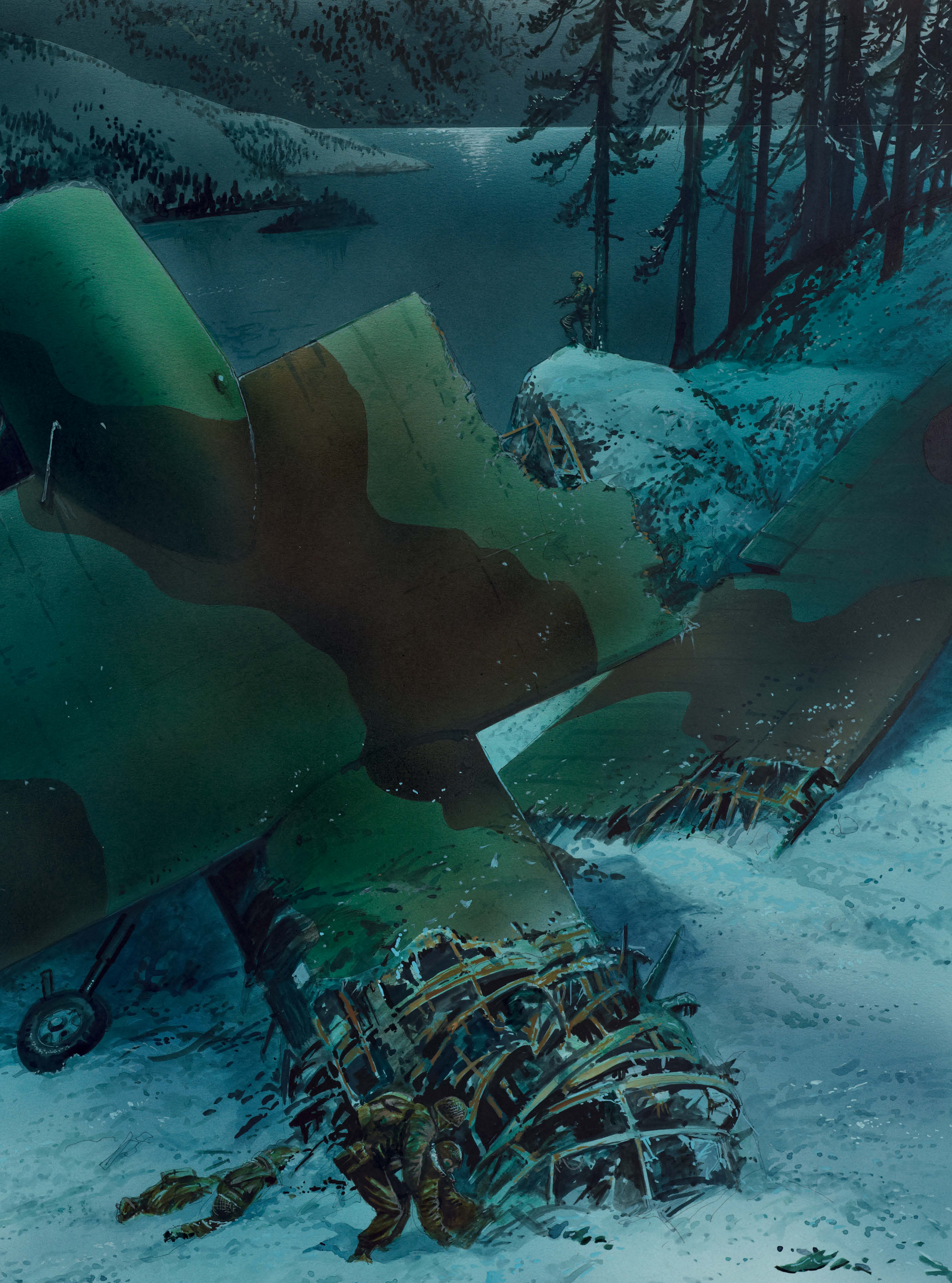
heard about the execution of the soldiers in the other glider and was determined these survivors should be interrogated. The Gestapo and Wehrmacht argued about jurisdiction over the captured soldiers. The army claimed it had authority, as the men were captured in battledress. The Gestapo thought that because they were wearing civilian clothes under their uniforms they were spies. Norwegian ration cards and money were found in the gliders, which showed an intention to stay as civilians. Also discovered were explosives, radios and a map showing Vemork as the intended target. The four wounded men were interrogated by the Gestapo, but they were in no condition to be questioned and were executed. Five men were taken to Stavanger by Gestapo commissioner Kuhn. They were then taken to Grini concentration camp where they were interrogated by SS-Hauptsturmführer Wilhelm Esser from the SD. He discovered that the soldiers were sent to destroy the plant at Vemork. On 18 January the soldiers were shot; they thought they were going to a prisoner of war camp in Germany.

A German communiqué read: ‘On the night of November 19–20th two British bombers, each towing one glider, flew into southern Norway. One bomber and both gliders were forced to land. The sabotage troops they were carrying were put to battle and wiped out.’ Henniker thought this was not true. He decided to say nothing about the raid. Their relatives were not to say anything. Early in December the Military Attaché in Stockholm reported rumours that the soldiers captured at Egersund had been shot. In January a report from a Norwegian agent questioned in the same prison at Stavanger where the soldiers had been kept in November or December stated that four prisoners were not wounded and five were badly wounded. The Gestapo were said to have found a map with Rjukan indicated as a target. The informant was asked to be an interpreter. SOE realised that the Germans were well aware that the British intended to destroy the plant.

Glider crash (overleaf)

A Horsa Mk I glider with two pilots and 15 soldiers, sent to destroy the electrolysis plant at Vemork, has crashed during the night in a remote area called Fylgjesdalen, on a hillside strewn with boulders, above a lake on the north side of Lysefjord. The glider’s tow rope had snapped when the towing aircraft, unable to identify the landing area, was attempting to return to base. The glider descended at a high angle; the front half is crushed, the wings have snapped off and the back end has detached. Eight men, including the pilots, have died. There are nine survivors. The soldiers were wearing civilian clothing under their battledress as they were supposed to escape on foot to Sweden after the attack. They have Sten guns and webbing, but their rucksacks with their white camouflage smocks were thrown about everywhere when the crash occurred. Only five men are uninjured and they are helping the dazed survivors; in the morning two of them would obtain help from a local farm.





THE PLAN

When he heard of the fate of the engineers, Wilson immediately volunteered to have *Grouse* launch the attack on the plant; Gubbins said the raid would be fraught with risk but gave his consent. SOE took over from Combined Operations and decided to continue with plans to sabotage the plant. Operation *Gunnerside* would be implemented to insert six men from the Norwegian Special Forces Company onto the Hardanger. Wilson spoke with Lt Joachim Rønneberg of SOE's Norwegian Section and told him to pick expert skiers from the Royal Norwegian Army volunteers and join Poulsson on the Hardanger Plateau. The volunteers chosen were soldiers that Rønneberg had trained at STS: Sgt Fredrik Kayser, Sgt Hans Storhaug, Lt Kasper Idland and Sgt Birger Strømsheim. Lt Knut Haukelid was appointed as the second in command. Rønneberg and Strømsheim had already prepared for an operation on the Hardanger. Rønneberg had not chosen Haukelid; he was uncertain whether he would get along with the lieutenant. Rønneberg lacked military experience and did not have a problem with authority, but Haukelid was something of a veteran and a loner. The operation was approved by the War Cabinet, despite Gubbins having his doubts.

Gunnerside's main objective was the destruction of the heavy water stocks in the basement. Brun advised on the building of a model of the 18 electrolysis cells that the saboteurs used during training at Hatfield in Hertfordshire. They practised laying charges and familiarised themselves with the detonators and explosives needed. They studied aerial photographs of the plant and the gorge, as well as diagrams of the buildings. Sometimes they asked questions that Tronstad could not answer; whenever that happened he would ask Brun. The latter had supervised the expansion of the high concentration room where the cells were located and knew what they looked like and where explosives would do the most damage. He advised on where the German barracks were and where the saboteurs could hide. He told them about an unlocked entrance to the basement

Joachim Rønneberg was from Ålesund; he was working in a fish farm when Norway was invaded. He decided to get out and return to fight in the open rather than stay and try to be a nuisance, so in March 1941 he was a passenger in a fishing boat that took him to Scotland; initially he was reticent about joining SOE, but he was soon a proficient saboteur and became the instructor at the Norwegian SOE training school in Scotland. He chose men that were quiet, unassuming types who would make good team players. The volunteers were all told of the fate of the initial attack. (Norsk Industriabeidermuseum. Foto: Ukjent)

where the cells were – a cable duct leading from outside the plant. While working at the plant he had to crawl down the duct to look at a leak that was occurring in a pipe into the high concentration room. The duct led to the ceiling of a room adjacent to the high concentration room that could be accessed through a grating. Brun stated there was enough space for a person to crawl through the opening and very few people knew about the entrance. Rønneberg and his team did not know that Brun was supplying this information, as his parents were still in Norway under German surveillance. Tronstad did not want his presence revealed if the men were captured and questioned.

The Nobel 808 plastic explosive that they would use was able to be stretched, shaped and even thrown, and would only go off when a detonator that could be stuck inside went off. The explosive would also go off in water. Rønneberg's men practised laying charges and familiarised themselves with the detonators and explosives needed. They made a daisy chain of nine ½lb charges connected with a detonator cord, rigged with a 2-minute fuse to puncture the cells.

At the glider crash sites the Germans found a map of the Norsk plant and explosives. Rediess warned Berlin that the British placed great emphasis on destroying the Vemork heavy water plant and on 4 December, under the guise of a false air-raid warning, 200 German soldiers made searches of the houses in Rjukan. If any contraband was discovered the residents would be taken for questioning. Twenty-two were arrested. The same day Reichskommissar Terboven and von Falkenhorst visited the plant. Von Falkenhorst warned that specially trained raiders would use the most arduous route to approach the plant. The garrison at Rjukan was strengthened to 200 soldiers with 30 at the plant, and work started on a minefield to surround the plant. The garrison at Møs Dam was increased to 40 men.

At Kalhovd Dam Torstein Skinnarland was seized; the Germans thought that he was Einar, rumoured by informers to be involved with the resistance. Rolf Sørlie, a friend of Poulsson and Helberg, had two radios hidden in the attic, but they were not found. On 9 December *Grouse* reported that two Gestapo radio D/F stations had started to operate from Møs Dam. The next day Gunnar Syverstad told Olav Skogen, the resistance leader in Rjukan, that the Germans were heading for Einar's house. A resistance courier got there first and warned the family; the courier was arrested on his way home. Einar fled to Nilsbu, a remote cabin in a heavy pine forest that in winter was covered in snow. On 27 December Skogen

In December 1941 Knut Haukelid had completed three weeks' basic training and went to Scotland for special commando training. In the 1930s he had studied engineering in Berlin and when Norway was invaded was working for the family firm importing engineering equipment but soon volunteered for the militia. He joined the resistance whilst working at the submarine base at Trondheim and fled to Sweden when the Gestapo were closing in on him during September 1941. Haukelid thought he should be leading *Gunnerside*. (Norges Hjemmefrontmuseet)

was arrested. Einar was told by Tronstad that he could leave Norway, but, aided by local families, he chose to stay. He visited *Grouse* and told them of Skogen's arrest.

On the barren plateau the *Grouse* team had to fend for itself through a Norwegian winter. Poulsson was 2½ miles from a German position on the Møs Dam and felt vulnerable. He had gone with his team to the Hardanger Plateau; initially to a hut called Grasdal then to a small cabin called Svensbu (also called Fetter) that he had built before the war at Lake Store Saure, about 18 miles from Rjukan and not marked on any map. There they were told to wait for the arrival of Rønneberg. With Torstein no longer able to supply food, the men had to fend for themselves. They went to the depot and retrieved their containers. They had a diet of reindeer moss and had to dig through the snow to the surface of the rocks that it grew on. They boiled the moss in snow water with oatmeal. Helberg recalled how 'On this meagre food, our strength and resistance to disease decreased rapidly'. (Quoted in Gallagher, p.75) He and Kjelstrup gained weight because of edema (water retention). On 12 December Sørlie arrived at their cabin and gave Helberg his rifle.

Survival on the Hardanger was challenging. Poulsson went on reindeer hunts, but initially with no luck. The men developed fever, but they had to keep on gathering firewood. Then Poulsson detected tracks and followed them to a herd of reindeer that had gathered near a lake. Staying stationary, the cold began to intensify as he waited for them to move to rougher terrain, where he could approach unseen. He crawled closer, to a knoll 200yds down the hill with the wind in his favour, but two that were closer than the rest observed him and bolted and made the rest move. He then noticed that some had gathered on a small plateau and he could make use of the slope to approach unseen to within 200yds. He fired three times and hit three reindeer, but they were only wounded and stumbled off. He caught up with one and fired again. The reindeer to him was 50lb of meat. With his rucksack full and leaving behind lean cuts in reindeer pelt to be retrieved the next day, he skied back, reaching the cabin in the dark. As the winter progressed more reindeer migrated to the plateau and hunting was frequently successful. They would need to spend some time waiting. On 17 December Haugland received a message that *Gunnerside* was ready to leave, but was then told it was delayed because of bad weather.

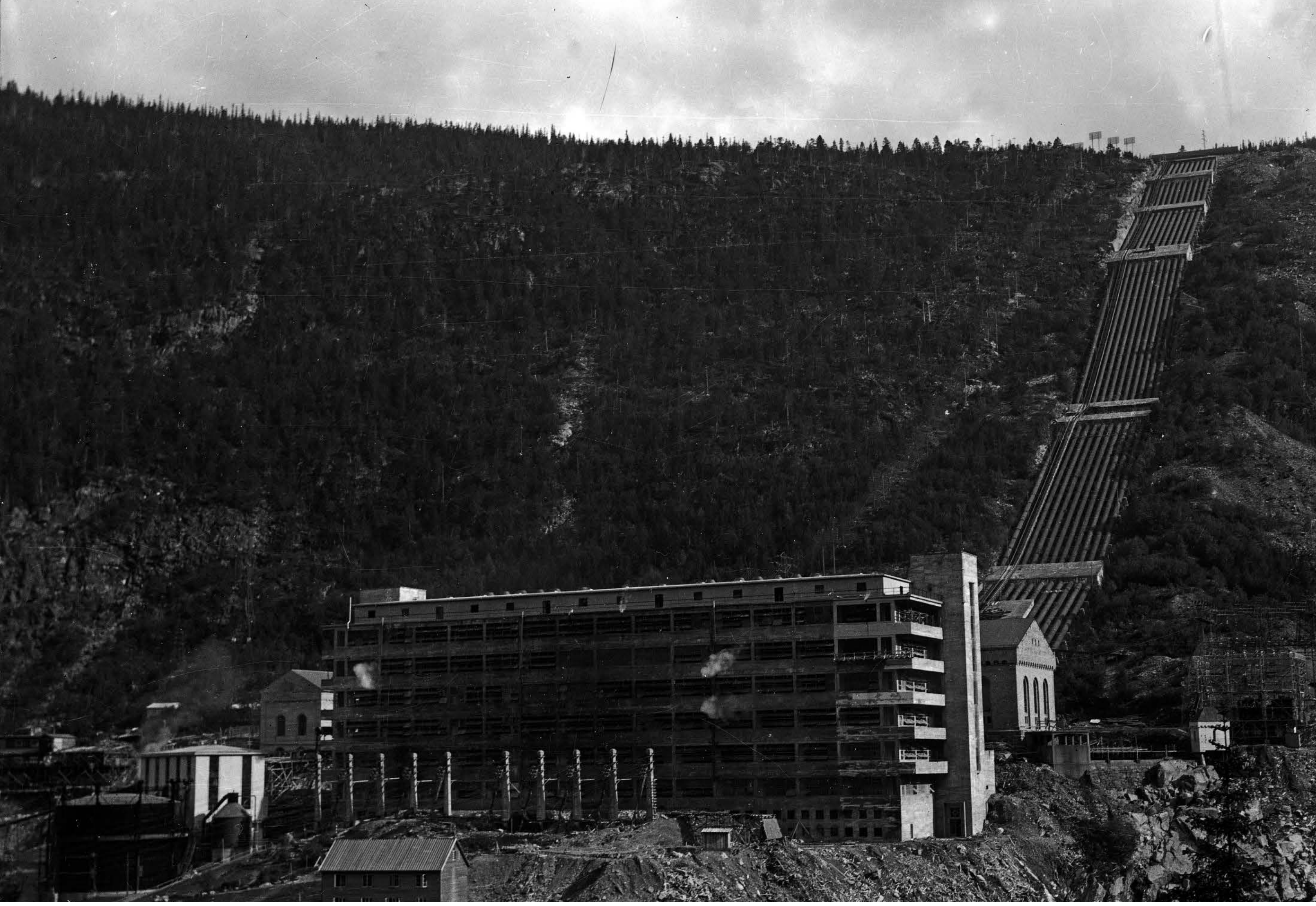
On 10 December Rønneberg travelled to London to choose his equipment. They were equipped with modified rucksacks that had additional compartments, a white covering and a drawstring top. Their sleeping bags, weighing 5lb and measuring 7ft by 3ft, were from Hamptons Ltd; the outer layer was waterproof and the inner layer with head zip fastener and breathing hole was large enough for a fully clothed person. Even with wet clothes on, the men would be able to sleep in the open comfortably. They modified their battledress and created small pockets. A peaked ski cap had the cold leather lining removed and replaced with a warm thick khaki material. Two sets of camouflage suit were taken; only in cold weather or a snowstorm would both be worn. Rønneberg's men did not use the jump suits, preferring to use their white camouflage suits and a padded ski cap instead of a helmet. A Primus stove was carried but was heavy; a second stove was abandoned because of the weight. Two quarter tins of paraffin capable of cooking 16 meals in total were carried. The rucksacks had white covers that kept snow out and everything inside the pockets dry. Skis were chosen from the stock at STS 26 and painted white.

The heavier Thompsons (10lb) were taken instead of the lighter Sten guns (7lb); the latter were thought to be unreliable as they sometimes fired in bursts when set to single shot. The ammunition calibre of the Thompson (.45 ACP) was the same as their Colts. Each Thompson had two spare magazines and 300 rounds. A sniper's rifle was also taken but the sights broke on landing. (Photo by Lt. W T Lockeyear/ IWM via Getty Images)

The rations were packed in canvas instead of cloth bags and Rønneberg reported that they would break. Because the rations were in a mess when the bags broke, it was difficult to judge how much to have. Only a single five-day bag of rations would fit in the rucksack; the men had to empty the bags to carry larger amounts.

On 22 January 1943, before boarding the aircraft, Rønneberg's men were told by Tronstad of the importance of their operation. They were given capsules of poison in case of capture that were placed into the pocket of their battledress made for the first-aid bandage. At 2000hrs the Halifax started its engines and slowly accelerated before leaving the ground and taking off. They flew at 10,000ft and crossed the Norwegian shore, descending to fly in the valleys to avoid German radar, and from this height could spot houses and people as they flew on. Einar had the Eureka working at the end of Lake Store Saure; however, cloud blocked out the red lights that *Grouse* had laid and the pilot decided to return home. The pilot reported that there was no signal received from Eureka and the crew did not see the lights. They thought they identified Lake Møs, but ice seemed to have altered the shape. Rønneberg's men could not identify where they were either. Low on fuel, the pilot returned to Kinloss. The RAF navigator was criticised and SOE thought the men should have found a suitable location rather than return. On 1 February *Gunnerside* went to Scotland to continue training. Rønneberg told Tronstad that he wanted hard physical training practising their survival skills and marching with full packs rather than stay in England.

Instead of Poulsson showing them a landing area or the RAF being able to identify where they were, the decision was taken that Rønneberg's team would make their own way in after parachuting onto the plateau. On 16 February, during a full moon, the Halifax took off and, to avoid flying over Rjukan and the Møs Dam, they descended at midnight 20 miles from Poulsson's cabin, near the frozen Lake Skrykken, 20 miles from where Rønneberg thought they were (at Bjornsefjord) and 40 miles from Vemork. Although the flight took place in good weather with clear moonlight to identify the prominent features, the landing site was not identified. The pilot thought he had a Eureka signal. Rønneberg reported how the moonlight and snow made identifying the ground difficult and there was a risk of injury. He did not know if the pilot had identified where they were. They jumped from 700ft. Six containers with equipment were supposed to land first followed by the six men interspersed with five containers that had their skis, rucksacks and toboggan, but Rønneberg reported that the equipment containers were last to land, although they were close together and in a spot that could be used as a depot. The distance between the chutes when they landed was about 800yds. A container with rucksacks was dragged 1½ miles, but was kept in sight and retrieved from an open ice crack. Inside a rucksack the frame was damaged and a sleeping bag torn. The contents of the containers were not known and they all had to be opened to re-pack what was needed for the advance; the rest was hidden. Stakes were placed to identify where this depot was



placed. This was completed by 0400hrs on 17 February in driving snow. Rønneberg would later report that if what was needed for the depot had already been packed in a container then this process would not have taken that long.

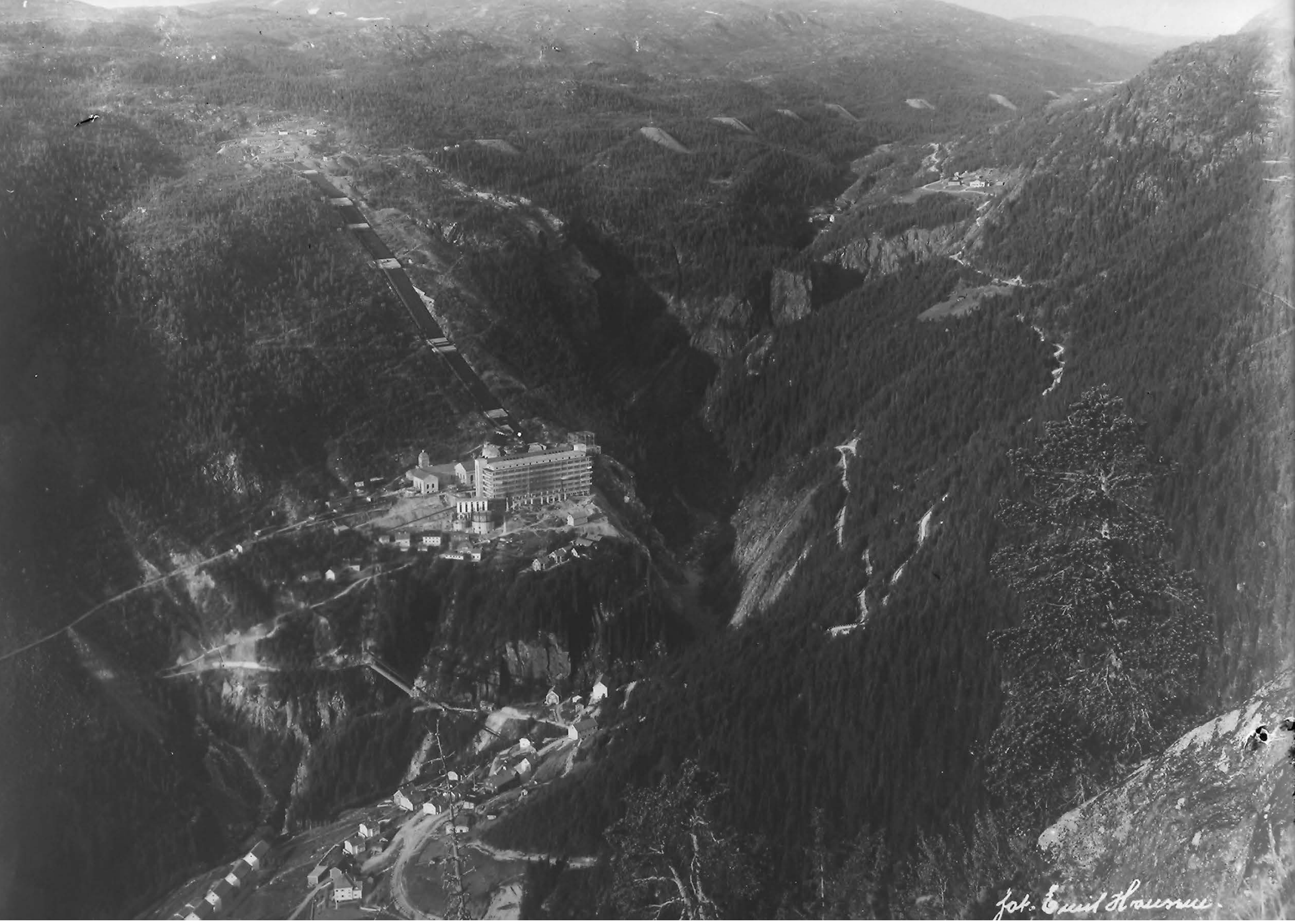
Storhaug then, by accident, found a hut called Jansbu, an unoccupied cabin a mile from where they landed; as the weather was worsening they decided to stay there to rest for a while. They then skied out at 1700hrs in strong wind and driving snow with packs weighing 66lb and two toboggans of 110lb, but Rønneberg realised that they were not skiing over a lake but over ground. They returned at 2000hrs, a decision that saved them from disaster; from a map in the cabin Rønneberg guessed that they were at the spot that was dirty with fingerprints. They also found a logbook for fishing on Lake Skrykken, some 20 miles north-east of where they were supposed to be. The morning brought a storm; 50mph winds created 40in snowdrifts. On 20 February Rønneberg went outside to fix a chimney brace and was thrown off the roof. He had trouble finding the cabin. With some difficulty, that same day, they found their depot and re-marked the spot. Rønneberg stated later that Poulsson had thought the storm had destroyed them.

Only on the sixth day (22 February) did the wind abate and clear skies return. As some of the men were feeling ill, they lessened the weight in their packs to 55lb and the toboggans to 55lb and 66lb. They took

Von Falkenhorst had thought the rear of the plant was most vulnerable. The attack on Glomfjord had targeted the pipelines and Von Falkenhorst recommended the laying of mines to protect them. (Norsk Industriabeidermuseum. Foto: Holtan, Alfred)

16 FEBRUARY 1943

***Gunnerside* team is inserted by parachute onto the plateau**



According to the plan, the SOE team arriving on 16 February 1943 would be met at the landing place or at the Svensbu hut (also called Fetter) when weather or security precautions allowed. They would advance to a forward base close to the target and make a reconnaissance of the plant to decide if the raid was still practical. The approach to the target would only be decided once they made this reconnaissance. *Gunnerside* would withdraw to Sweden after the raid and the rest of the team would stay in Norway. (Norsk Industriabeidermuseum)

uniforms for Poulsson's team, the explosives and rations for ten men for five days. They were preparing to leave at 1300hrs when they noticed a skier with a sledge behind him 200yds distant. He left the sledge and headed towards the cabin. Rønneberg watched him notice the ski tracks made by his men. Before he could reach the cabin the saboteurs burst out and surrounded him. He identified himself as Kristian Kristianson, from Uvdal on the border of the Hardanger, out reindeer hunting. Thinking he had met soldiers sympathetic to the pro-German regime, he said he was a Quisling supporter, though he had not yet got around to joining the party. Idland offered to shoot him. Rønneberg refused this request; he asked Kristianson whether Uvdal inhabitants would confirm him as a Quisling; this was something Kristianson said he could not agree would happen. Upon this response Rønneberg decided to use him as a scout, despite showing no sympathy for the king or the government in exile. He made him sign a declaration that he had a gun and a list of black market customers; they threatened to send this to the security police in case of betrayal. What to do with him in the longer term was still a dilemma. Rønneberg would have to let him go before the attack on the plant. They could not leave him in a cabin with only limited food or deprive him of his skis and rifle if they wanted him to stay alive. If they let him go after joining with Poulsson then he might have time to inform the Germans.

They decided to make use of his local knowledge. To lessen his chances of escape they made him pull a toboggan.

They set out that night. The skier took them along an excellent route to the cabin he had stayed in during the storm at Hettevan. They rested at 0400hrs until sunrise. Then at Kallung, when skiing down a slope to Grasdalen, they noticed two men skiing in the valley. Kristianson was terrified that they were German and hid behind a boulder. Haukelid was ordered to make contact. 'We kept waiting behind the boulders, our hands near our holsters,' Rønneberg later stated. 'Then suddenly, above the noise of the wind, there was a wild yes of pleasure. We had at last joined with the advance party'. (Quoted in Gallagher, p.107) The two skiers were Helberg and Kjelstrup. They discussed the problem of what to do with Kristianson and decided 'We could not leave anyone behind to guard him while we carried out the attack, and we could not lock him up to starve. Despite Idland's objections, we decided to set him free, under the threat that the information we had on him – his rifle, which was strictly forbidden, his black-market list, which would implicate his customers, and his assistance to us – meant that the Gestapo would kill him if he divulged any information'. (Rønneberg, quoted in Gallagher, p.107) Once they reached Poulsson's cabin at Fetter at 1600hrs they decided to let him go with rations for a week (he was also given English chocolate) and told him not to return to Uvdal for three days. He was not brought to Fetter to protect its whereabouts. Skinnarland was also told to leave Fetter before

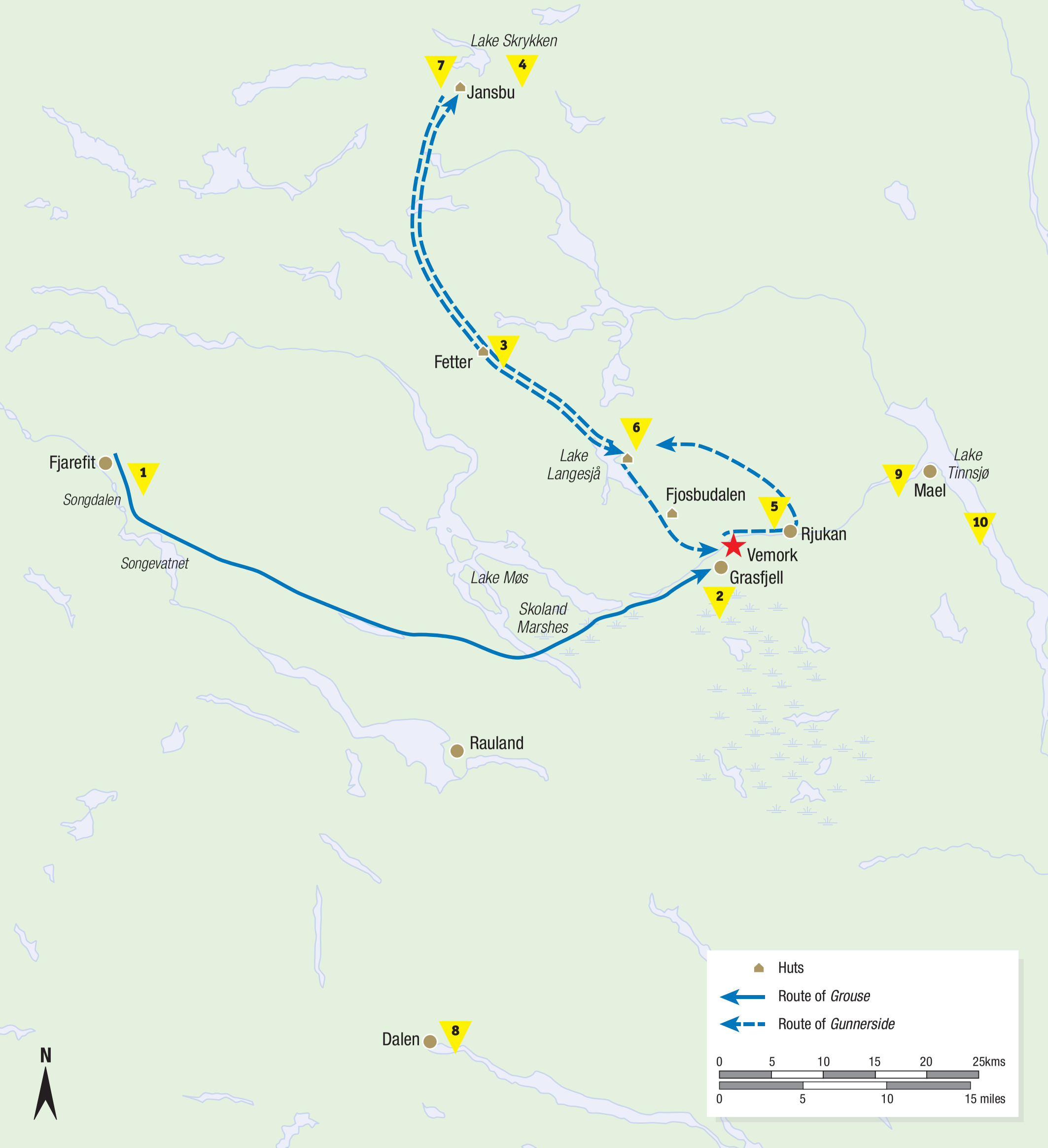
On 17 February 1943, the day after they landed, Rønneberg recalled how 'the snowfall was thickening and the wind increasing. A storm was obviously on its way, and we were not even sure we were travelling in the right direction. There was nothing to do but return to the cabin and await developments'. (Quoted in Gallagher, p.97) Here Tronstad is seen moving with equipment in heavy snow when he was deployed to Norway in 1944. (Norsk Industriabeidermuseum. Foto: Longum, Per)

Rønneberg's team arrived to keep his identity a secret; he went to the cabin at Jansbu on Lake Skrykken to establish a radio base.

Rønneberg's team prepared their equipment. He made his detailed plans. Haugland departed to establish the radio with Skinnarland. Four men (Rønneberg, Kayser, Strømsheim and Idland) would be the demolition party and five men led by Haukelid, and including Poulsson, Helberg, Kjelstrup and Storhaug, would be the covering party. Rønneberg drew the layout of the plant from sketches that Tronstad had shown him and specified the basement where the electrolysis cells were as well as the barracks room that held 15 guards. He told them about the railway that was used infrequently to bring in machinery and equipment to the plant. The track passed through an iron-barred gate in the fence that surrounded the plant. He sketched the barracks opposite the plant and the storage tanks 20yds from the barracks that would make good cover. He told them that the cable duct could be used to gain entry to the electrolysis cells, but would only be used if the doors were locked; if the duct was blocked they would have to demolish the doors, despite the noise this would make. Rønneberg told them that the hydrogen burners could make a noise when started or if the flow of gas fell. The guards were used to this happening and an explosion caused by them might be mistaken for the burners going off.

Rønneberg was still debating how to get into the plant and out again. Tronstad had recommended the gorge approach; Helberg suggested this route despite being told the cliffs could not be climbed. Poulsson thought that the gorge was not an option. Haukelid recommended crossing the ravine at the foot of the plant, instead of assaulting the bridge, which was bound to attract too much attention; once the shooting started reinforcements would arrive from Rjukan and there would be no hope of escape. They needed about 30 minutes to lay the explosives; if they were discovered, a counter-attack could occur and prevent them from detonating them.

Poulsson, during his stay in Fetter cabin, described a typical day. He would wake at 0730hrs and light the kerosene lamp and stove, using shavings and dry wooden sticks, and then boil oatmeal and reindeer meat kept frozen in the snow by the cabin wall. Reindeer pelts covered the floor but the cold still penetrated from the roof. He smoked his pipe – he was the only smoker in the group. They checked the weather. He would start to prepare dinner while Helberg went hunting, Kjelstrup brought in firewood and Haugland worked on the radio. (Norsk Industriabeidermuseum. Foto: Kårvand, Ingelinn)



EVENTS

1 18 October 1942: SOE's *Grouse* team lands east of Fjarefit in the Songdalen, 30 miles from Vemork.

2 5 November 1942: *Grouse* reaches Grasfjell, on Lake Sand, east of the Møs Dam. Helberg skis over to see Torstein Skinnarland and obtains a battery for the radio from him.

3 Early December 1942: *Grouse* retreats to a hut called Fetter to avoid German patrols. Haugland receives a message that *Gunnerside* is delayed. *Grouse* has to survive on the barren plateau.

4 16 February 1943: *Gunnerside* lands east of Lake Skrykken, 40 miles from Vemork and about 20 miles from Fetter hut. They find a hut to weather a storm. On 22 February they notice a skier approach their hut; they force him to help them. The following day they reach Fetter and unite with *Grouse*.

5 26–27 February 1943: Helberg meets with Sørlie in Rjukan and is told the latest intelligence on the German defences. He reports to Rønneberg at Fjøsbudalen that the railway gate is unguarded and then is sent to reconnoitre the gorge to determine whether this approach to the plant is practicable.

6 1–3 March 1943: Following the attack on the plant at Vemork the previous night (28 February/1 March), Rønneberg and his team retreat to a hut here on Lake Langesjå. Helberg is separated from them as he had to return to Fjosbudalen to change into civilian clothes. By 2000hrs on 3 March Rønneberg will reach Jansbu hut. The following day *Gunnerside* will start their march to Sweden and the rest of the team will disperse higher on to the Hardanger.

7 25–26 March 1943: The Germans' search of the Hardanger has already started. Helberg, having returned from Oslo, is surprised by a German ski patrol at the Jansbu hut; he escapes the pursuers but is injured and skis south towards Rauland.

8 28 March 1943: In Dalen, Helberg, with other hotel guests, is detained following an encounter Terboven had the night before at the hotel; they are loaded onto a bus to be taken to Grini. Helberg escapes from the bus.

9 19 February 1944: Following the air raid on Rjukan the previous November, the Germans, having decided to remove all heavy water to facilities in Germany, bring 43 400-litre drums on railway wagons to Rjukan in preparation for a ferry trip over Lake Tinnsjø. Haukelid and Sørlie monitor the wagons. That night with Lier-Hansen they drive to Mael in order to place explosives on the *Hydro* ferry.

10 20 February 1944: The ferry loaded with railway wagons departs shortly after 1000hrs. At 1045hrs the explosives go off and the ferry sinks in the deepest part of Lake Tinnsjø. The wagons disappear into the lake; all but four half-empty drums of heavy water are lost.

Rønneberg asked Helberg if the railway was guarded or mined. He was not sure, but if they discovered that it was not, Rønneberg identified that the railway could be used to gain quick entry into the plant. Helberg offered to ask Rolf Sørlie, a friend who was a construction engineer at the plant, though he did not identify his name to the others. He departed on 24 February and would meet the others at a cabin in Fjøsbudalen on 26 February, where the Hardanger Plateau meets the river that flows through the gorge on the opposite side from Vemork, in a remote valley at 2,624ft with views over Rjukan but not Vemork. The cabin, a little over 4 miles from the target, was a good base from where they could mount the operation as the place was seldom visited yet close to the plant. On 25 February Rønneberg and the rest departed towards Fjøsbudalen.

Helberg met Sørlie at a cabin at the base of the Krossobanen cable car and Sørlie brought him to his home, where he stayed the night. Helberg discovered the Vemork and Rjukan area in lockdown with 300 guards, AA guns, searchlights and two Direction Finding stations in the immediate area; however, the railway line to the plant was unguarded. Sørlie reported that the gorge was too steep to climb, that the site had 15 guards rotating every two hours, and that the bridge had a guardhouse on the Vemork side with a soldier equipped with an MG that could switch on an alarm that would light up the whole area, alert the barracks at Vemork and the garrison at Rjukan.

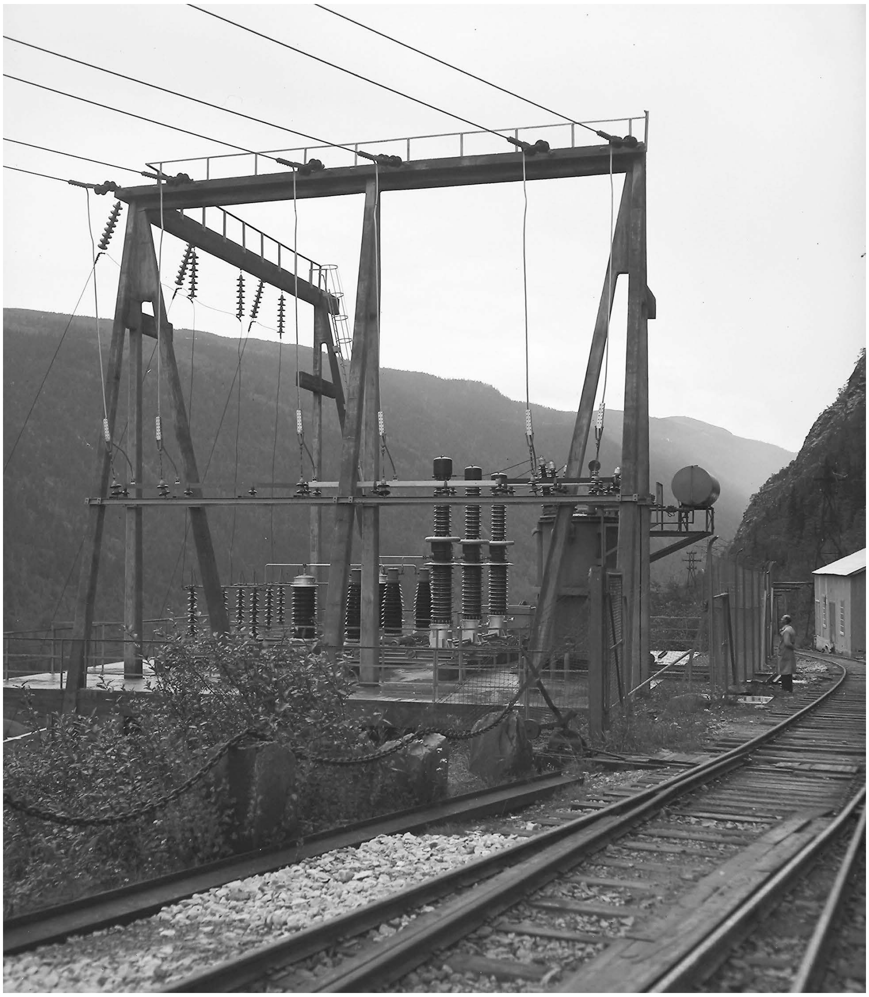
Helberg returned to meet the others at Fjøsbudalen. He told them the information Sørlie had told him: that there was a guardhouse alongside the road leading from the bridge to the factory ‘equipped with an alarm button. Machine guns and floodlights are mounted on top of the main building, and if the alarm is raised, the floodlights illuminate the entire area, including the penstocks above the building, the suspension bridge below the building, and the roads leading to and from the bridge. The

All the raiders were equipped with a Colt pistol. SOE recruits were taught not to aim at close targets and to fire a double tap – two bullets – to ensure their target was incapacitated. At longer ranges the gun was raised for a proper aimed shot. Here, Poulsson is observing training with a Colt in the snow in southern Norway. (Norsk Industriabeidermuseum. Foto: Kårvand, Ingelinn)

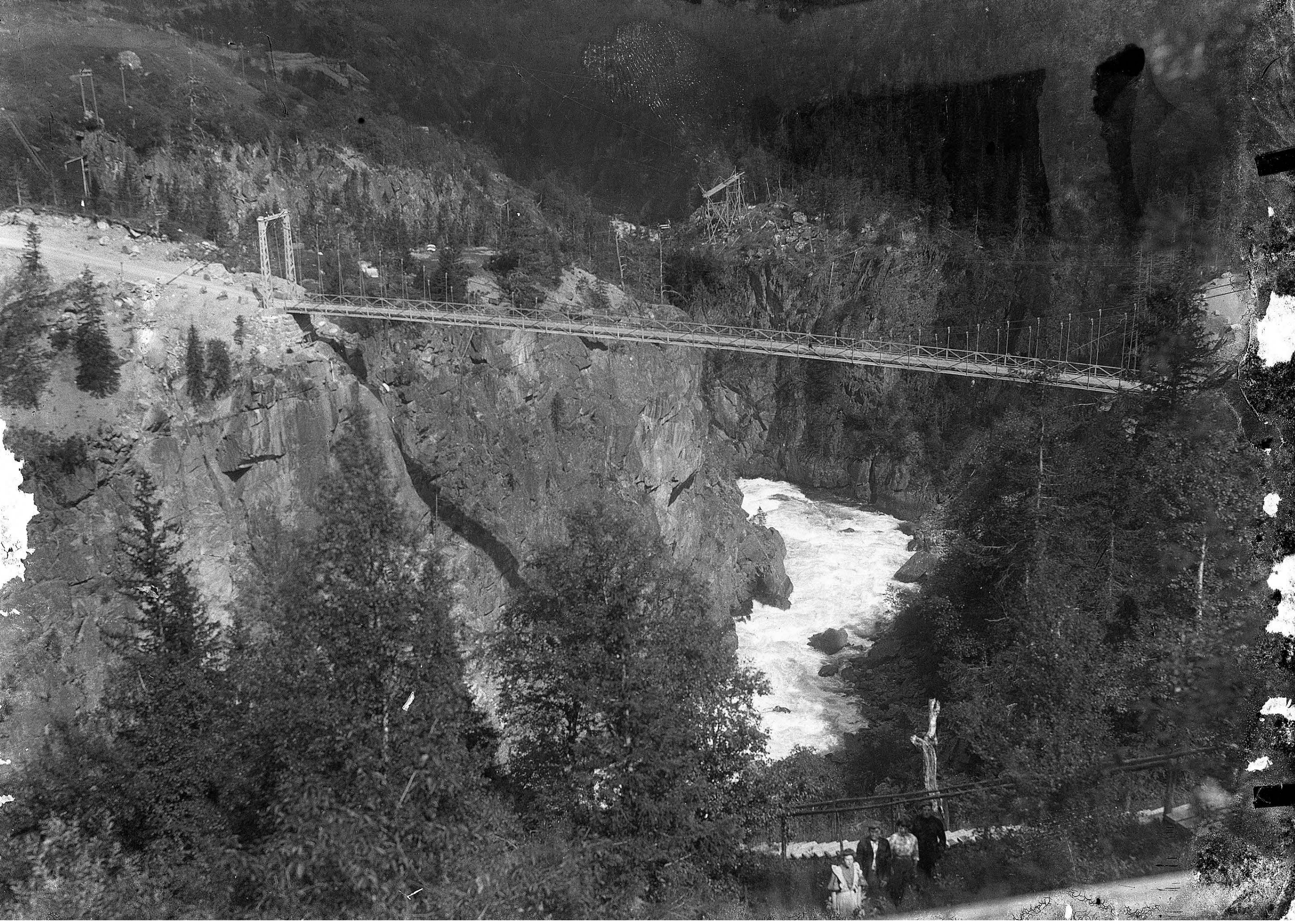
German soldiers in the barracks just outside the building are also routed out, and the German garrison in Rjukan, only a few miles away, is alerted'. (Helberg, quoted in Gallagher, pp.115–16) The gorge and the railway were not guarded.

The aerial photographs showed small trees growing on the slope of the gorge, suggesting that the cliff was climbable. The pictures showed the scene in summer, so they needed to check whether they could cross in winter. Rønneberg told Helberg to make a reconnaissance of the ravine in daylight the next morning; he was given a sketch of the valley and a description of the route they intended to use, illustrated with aerial photographs. If seen in the valley they would surely be caught, but the gorge approach might not be seriously considered by the garrison as a means of entering the plant.

On 27 February Helberg reached the highway to Rjukan and instead of skiing down a U-bend that led to the hamlet of Våer he decided to walk to the cliff side, so as to avoid meeting people during the approach. Once there he looked for a place where a descent to the valley floor could be



Rønneberg identified that the railway into the plant was vulnerable and decided to enter through the railway gate. He wanted 'to try to cross the gorge beneath the bridge, climb the cliff to the railway tracks on the other side, and follow the tracks into the plant unseen. We know the Germans don't expect anyone to try that route, because the gorge itself is not patrolled'. (Quoted in Gallagher, p.112) Here the railway line is seen entering the plant. (Norsk Industriabeidermuseum. Foto: Ukjent)



There was intense debate about whether to use the bridge to leave the plant. Here it is seen over the Måna River. (Norsk Industriabeidermuseum)

made. He noticed that skis could be left by a road by a power line that was not used much. On the slope the snow had made a surface crust that allowed him to sink his boots in, but he soon encountered rock covered in ice and started slipping. He made use of deep snow on shelves of rock and used branches to cling onto to reach the frozen river a quarter of a mile from the bridge. He walked towards Rjukan and found an incline less steep with pine and spruce growing out of a groove in the rock that gave hand grabs and foot holds. A similar groove in the rock was found on the opposite side of the gorge that led to the railway track. The weather needed to remain cold in order to keep the snow compact, and the wind calm to permit a safe ascent.

Helberg reported his positive findings. They then discussed the return trip. Rønneberg disagreed with using the valley floor; he thought a quick exit would be needed and that could only be achieved by using the bridge. Idland suggested going over the bridge; he thought they had little chance of getting out. Poulsson agreed. They still thought that the noise of the explosion would wake the guards and that leaving the plant during a firefight via the gorge with searchlights on meant they could be trapped by the Germans in the valley. Poulsson questioned whether climbing the gorge twice in the same night could work; however, he did not want to kill the sentries and risk retribution on the population of Rjukan; the ravine would

**28 FEBRUARY–
1 MARCH 1943**

***Gunnerside* sabotage team gets into Vemork and blows up the electrolysis cells**

hopefully avoid such an eventuality. Helberg suggested climbing the gorge, but instead of climbing 1,500ft to the plateau through 3ft of snow, he thought skiing towards Rjukan towards the lower platform of the cable car lift and then using the Ryes Road, a maintenance track to get onto the plateau, a 1,640ft climb, a better option; though he was worried that if discovered the Germans could use the cable car to get to the top of Ryes Road and intercept them. Rønneberg put it to a vote and the majority (two were indifferent, five agreed, two wanted to attack the bridge) agreed to use the gorge to escape.

Rønneberg then discussed the sabotage of the cells and said the demolition party should take 7 minutes to complete the laying of the explosives. They would carry their guns loaded but with no round in the chamber in case of a misfire. They would wear uniforms without camouflage smocks. If the demolition party was killed prior to setting the charges, the covering party would attempt to set them. They would leave at 2000hrs on 28 February. The attack would be made at 0030hrs. The guards changed on the hour from 2000hrs every two hours. Rønneberg ordered that if wounded or about to be taken prisoner, they would take their own lives.

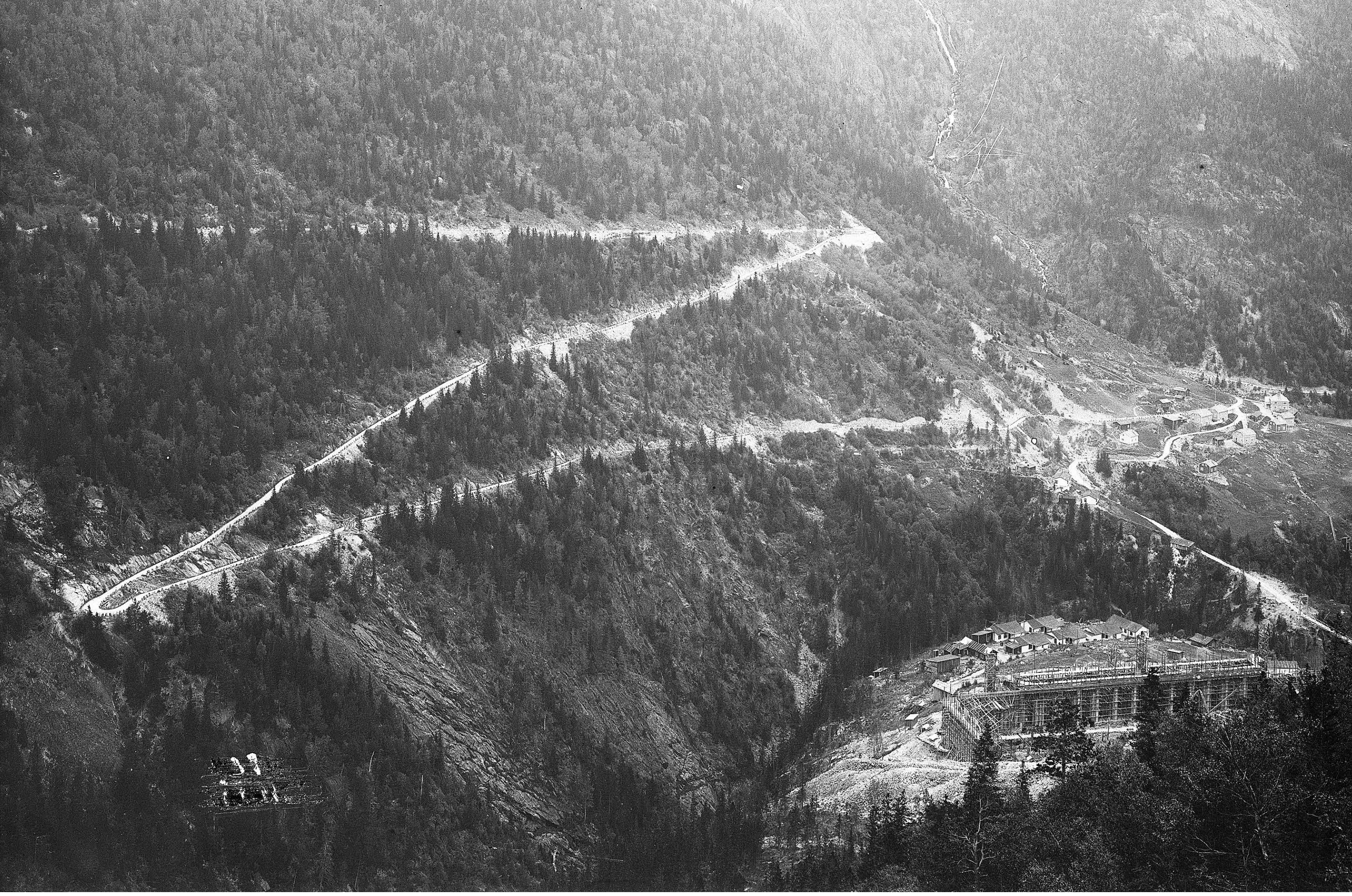
At 1700hrs the sentry brought in a skier; he was recognised and told not to report their presence. The wind had increased when they left the cabin at 2000hrs and headed out in moonlight towards the Rjukan Valley with Helberg in the lead.

THE RAID

They started to ski and then walked along Mosvann Road. Soon they had to walk through 3ft of snow down a steep slope following the line of the telephone wire through a wooded area, with 50lb in their rucksacks. They then reached the road and again used skis, slipping in heavy winds and icy conditions. Soon they could see and hear the plant. They removed their skis and went down the slope, missing out the U-bend. As they were reaching the lower section two buses approached from Rjukan, carrying the nightshift. They had to grab branches to slow their descent to prevent themselves sliding onto the road before the buses went past. Others already down had to hide in a roadside verge.

Helberg then led the way along the road to Vemork for half a mile, to the power line road close to the cliff, where they dumped their skis in some woods. They removed their white camouflage suits and packed them into their rucksacks, which they hid close to the road. The plant suddenly appeared, perched on the cliff on the other side of the chasm, looking like a fortress, built from rock hewn out of the slope. The pipelines – 5½ft wide – that sent the water into the plant were clear of snow; the friction caused by the water heated the metal, causing the snow on both sides to melt. The noise of the machinery in the plant and the water plunging into the penstocks were clearly audible. Rønneberg and Strømsheim made sure each had a set of charges in specially made rucksacks. Kjelstrup had some shears and rope.

They then plunged into the abyss. Helberg led the way. Their approach down the ravine went unobserved. Water was trickling down the sides and made the partially frozen river wet, increasing the chances the ice would break. They had a steep and slippery descent 328ft to the river. They found a crossing place they could use. The ascent on the other side of the gorge was steeper and 492ft high. If they fell, the rocks on the valley floor would cause severe injury. They were told not to look down during training, but many did. Making sure there were supports for every foot or hand before



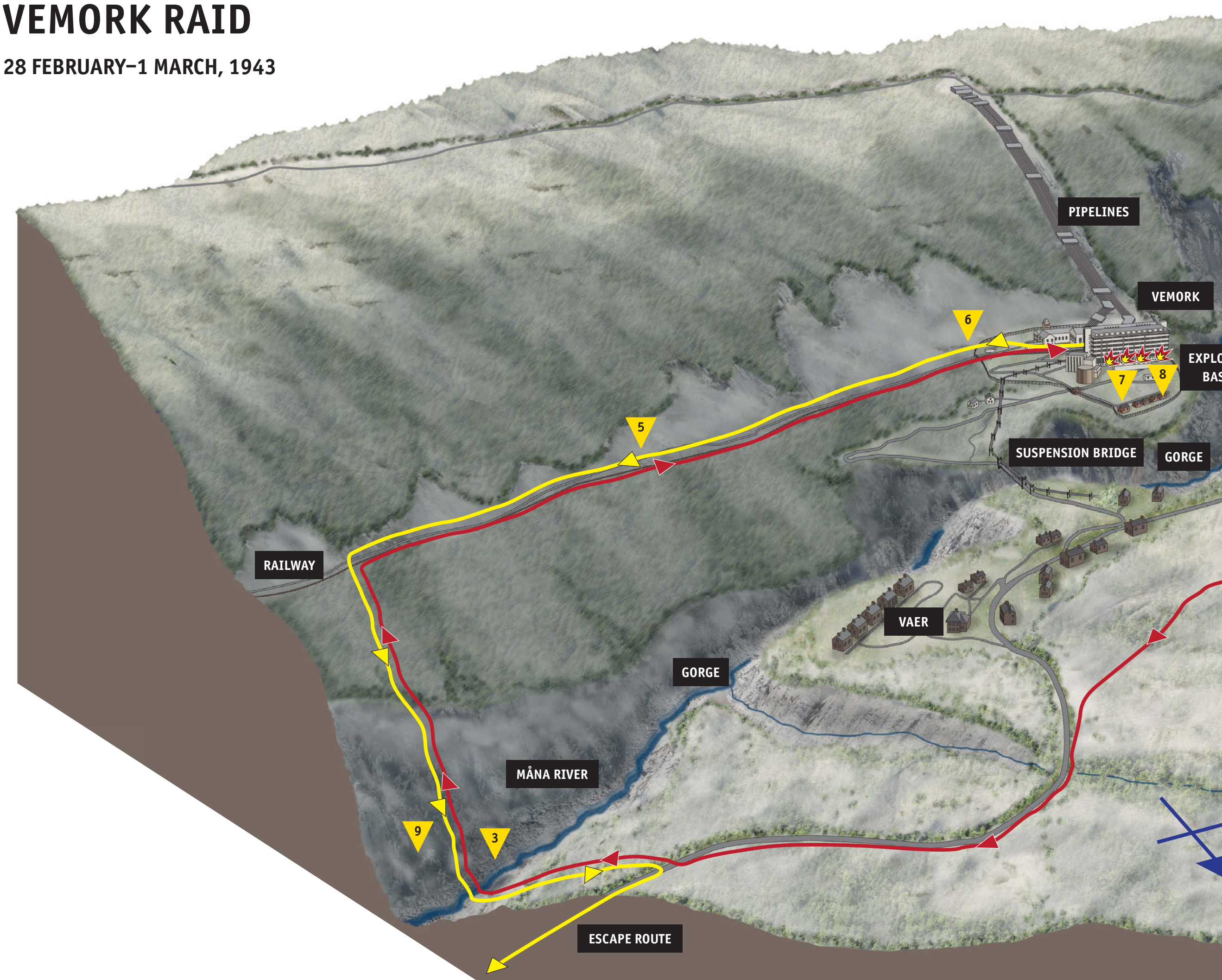
The network of roads that led to Rjukan and elsewhere had to be avoided as the Germans would use them once the attack was carried out. Here the U-bend that Helberg identified is clearly seen. (Norsk Industriabeidermuseum)

climbing higher was sometimes not feasible. Often both hands would be in the same hold and legs shook from muscle fatigue. Outcrops of rock and vegetation were searched for and grasped, but Idland, having covered 150ft, could only find a single hand hold and was dangling; he tried and failed to reach to his side in order to find a tangle of growth to steady himself. He had to let go to stretch out and find a new hold and for a time had no hold; only at the last moment did he grasp some roots. Then a gust of wind that would have thrown him off the cliff a moment before suddenly appeared.

Once they were at the top, they were half a mile from the plant's main buildings. The noise of the plant was heightened by the wind. Haukelid led the covering party – Kjelstrup, Helberg and Poulsson – in front along the railway line, with orders to attack the guards if the alarm was sounded; all had Thompson submachine guns (apart from Poulsson) and chloroform that could overwhelm the guards. Rønneberg reported that Poulsson carried ten grenades; however, Haukelid may have taken Poulsson's grenades and Poulsson may have had his Thompson. Rønneberg and the demolition party – Kayser, Strømsheim and Idland – followed 50yds behind. Rønneberg reported that Storhaug was part of the demolition party. Rønneberg, Kayser and Strømsheim had .45 Colts and each carried two magazines. Rønneberg reported that Idland and Storhaug had a Thompson and two magazines. All the raiders carried a Colt, either .32 or .45, with two magazines.

VEMORK RAID

28 FEBRUARY–1 MARCH, 1943


PIPELINES
VEMORK
EXPLO
BAS
6
7
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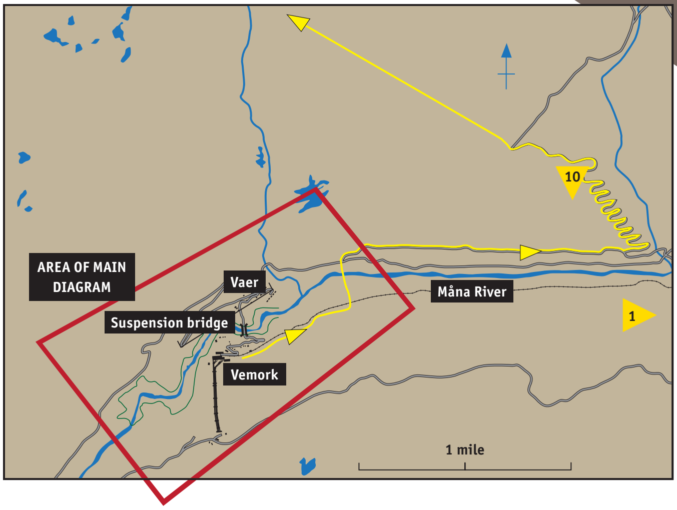
ESCAPE ROUTE

THE ESCAPE ROUTE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AREA OF MAIN DIAGRAM
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Suspension bridge
Vemork
Måna River
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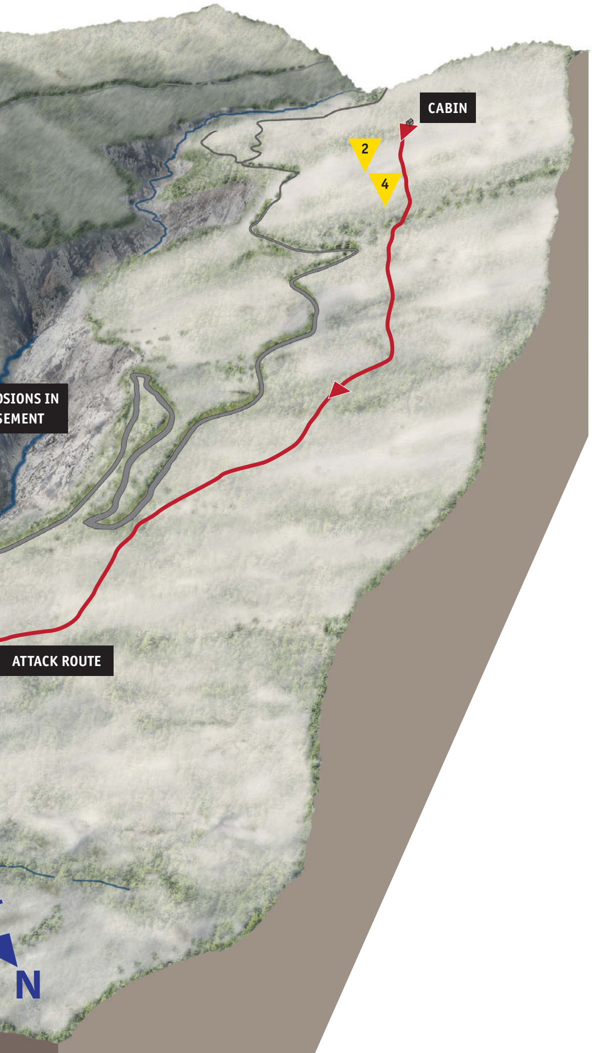
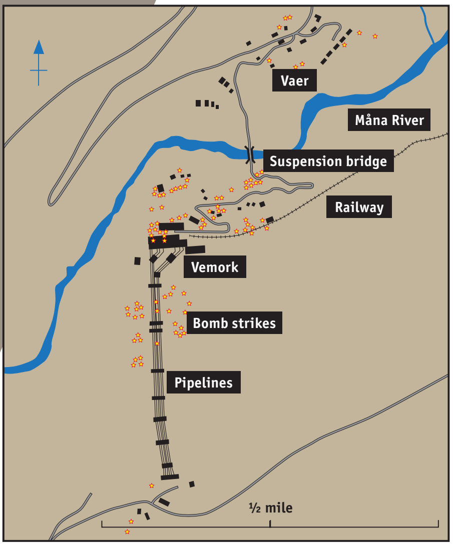


EVENTS

1. 25 February: Helberg meets Sørlie in Rjukan. He is provided with the latest reports on German defences.
2. 26 February: Helberg meets Rønneberg and the rest of the SOE team at Fjøsbudalen as planned. Helberg is told to reconnoitre the gorge to determine whether the approach to the plant could be made here.
3. 27 February: Helberg finds a spot near a road by a power line that is not used much and from here climbs down the gorge. On the valley floor he walks towards Rjukan and notices a groove in the rock that could be used to climb the other side. He reports his findings to Rønneberg.
4. 2000hrs, 28 February: the SOE team head out from Fjøsbudalen towards Vemork. They will use the route Helberg suggested down into the gorge.
5. 2330hrs, 28 February: Having ascended the cliff half a mile from the plant, the covering team led by Haukelid reaches a shed 550yds from the railway gate and waits for Rønneberg and the demolition team.
6. 2345hrs–0030hrs, 28 February–1 March: The team observe the guards at the entrance to the plant relieved at 0000hrs and wait for them to get comfortable. They then head to storage sheds 100yd from the railway gate. From here the final approach is made and the gate's lock is opened with bolt shears. Rønneberg opens a second gate 10yd down from the first and makes a hole in the fence 50yd from the gate.
7. 0045hrs, 1 March: Rønneberg and Kayser find the door to the electrolysis building locked and discover the cable duct. They enter and crawl through, lowering themselves into a room next to the room with the heavy water cells. They surprise a night worker in the room and Rønneberg sets the charges. A window is broken by Strømsheim and he enters to help Rønneberg whilst Idland stands guard in the road.
8. *c.* 0115hrs, 1 March: Rønneberg lights the fuse to the explosives and the demolition party hurriedly exits the building. The covering party hear a thud as the explosives goes off. Poulsson and Haukelid observe the door to the barracks open and a guard leaves; the guard looks at the building, checks the door to the plant building and then approaches their hiding place near the storage tanks. Haukelid orders Poulsson not to shoot and the guard returns to the barracks without noticing them. They then depart for the gate.
9. *c.* 0145hrs, 1 March: Helberg leads the team down the gorge. When they reach the river the sirens go off but no search lights are switched on. They climb the other side unseen.
10. 0500hrs, 1 March: The team have used the Ryes Road to ascend the slope by the Krossobanen cable car and reach the plateau. A storm hides their ski tracks as they head off to the Lake Langesjå hut.

VEMORK BOMBING, 16 NOV. 1943



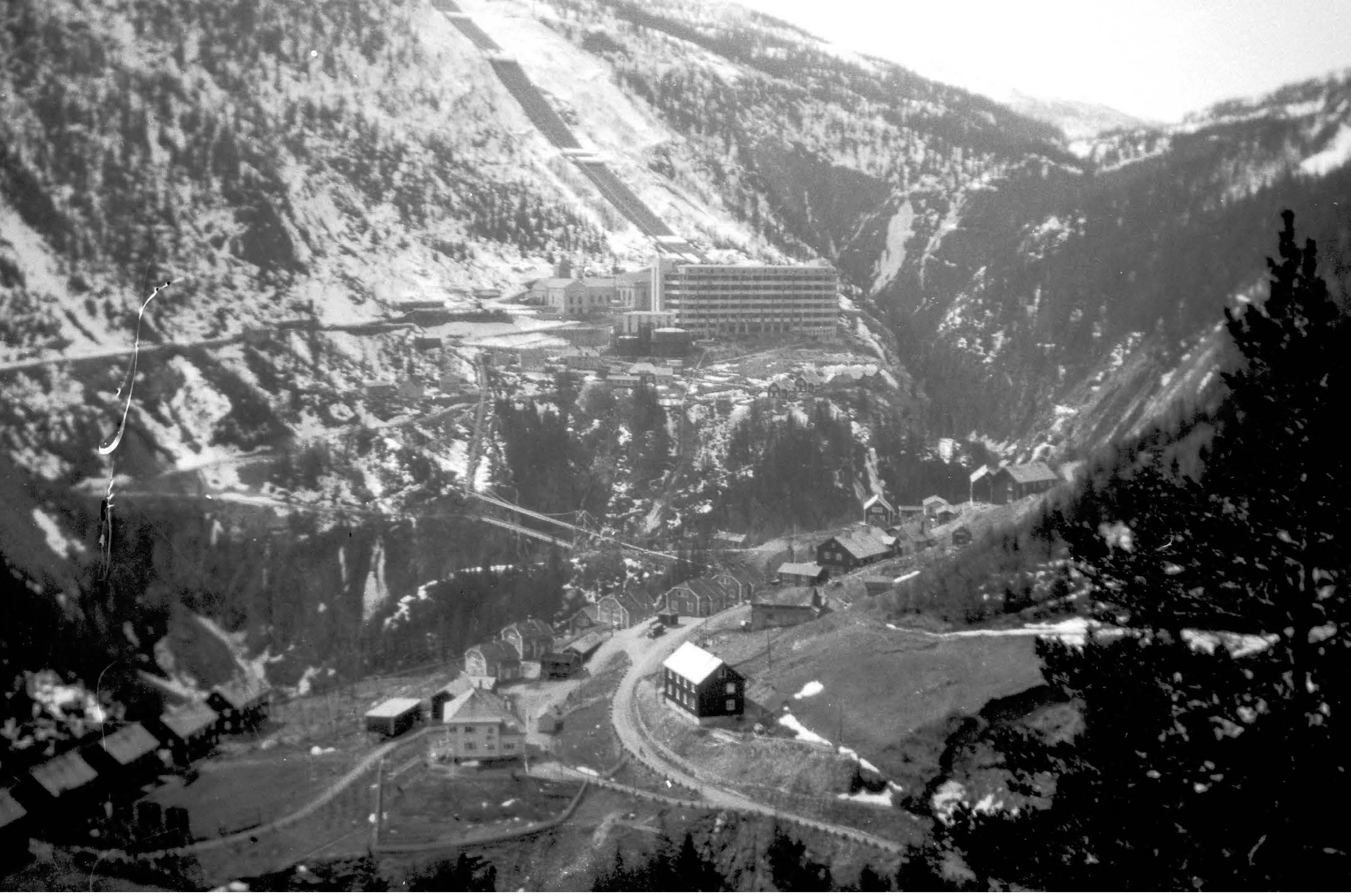
Kasper Idland did not think he would survive the raid; he told Rønneberg his skiing was not good enough to permit escape to Sweden, but Rønneberg told him not to worry. Idland had experience in the armed forces, having served as an army sergeant in the late 1930s. He re-joined the army when Norway was invaded, but he was captured. He was released and in September 1941 travelled to Scotland from Egersund. Following the attack on Vemork he would succeed in escaping to Sweden, despite his concerns, and in 1944 would return to Norway and operate in the Egersund region until the end of the war. (Norges Hjemmefrontmuseet)

Haukelid discovered a trodden path by the railway line and used this to avoid mines. He stopped at 2330hrs at a shed 550yds from the railway gate and waited for Rønneberg. They gathered together and stayed there from 2345hrs until the guards, looking tired and complacent, were relieved at 0000hrs. They took a break, nibbled on snacks and talked to distract themselves. Any sense of tension was gone. When the guards were relieved they gave them 30 minutes to get comfortable before moving off at 0030hrs to some storage sheds that were about 100yds from the gate. Rønneberg told Kjelstrup with the covering party close behind to go forward and cut the chain. He opened the gate from the railway siding into the plant secured with a padlock with bolt cutters. The electrolysis cell building was 50yds further on and towered above them. Rønneberg opened a second gate to some warehouses 10yds down the slope and made a hole in the fence 50yds down from the gate that could be used as an alternative escape route if they were pursued.

The covering party took up their assigned positions. Kjelstrup went left to observe the guard at the penstocks above the plant. Helberg took position to cover the two gates. Haukelid and Poulsson started towards the barracks; they went across an open yard and took position among two storage tanks that gave them a good view of the door to the barracks 15yds away. Haukelid lined his grenades up on the snow and Poulsson trained his Thompson on the barracks.

The demolition party went over to the eight-storey hydrogen plant, but found the door to the basement locked. Storhaug pressed on to view the guards on the bridge to make sure they did not approach the building. Rønneberg told Strømsheim and Idland to try the door to the ground floor. Tronstad had warned Rønneberg about not forcing the door as discovery would lead to retributions. With Kayser, Rønneberg looked for a window and through specks that were not painted over could see two lines of heavy water cells and a Norwegian worker sitting at a table positioned between them. He thought about breaking the window, but then remembered the cable duct and continued right, along paths where the snow had been cleared and was now piled high against the walls of the building. Strømsheim and Idland had gone the other way around the building. Rønneberg noticed a ladder beyond the north-east corner that went into a small opening in the wall 15ft off the ground. He cleared the snow off the rungs and climbed into the duct.

Rønneberg went in head first and used a torch, with Kayser behind him. Following cables and pipes he crawled 30yds, stopping halfway to see the worker in the cell room through a hole made for water pipes. When

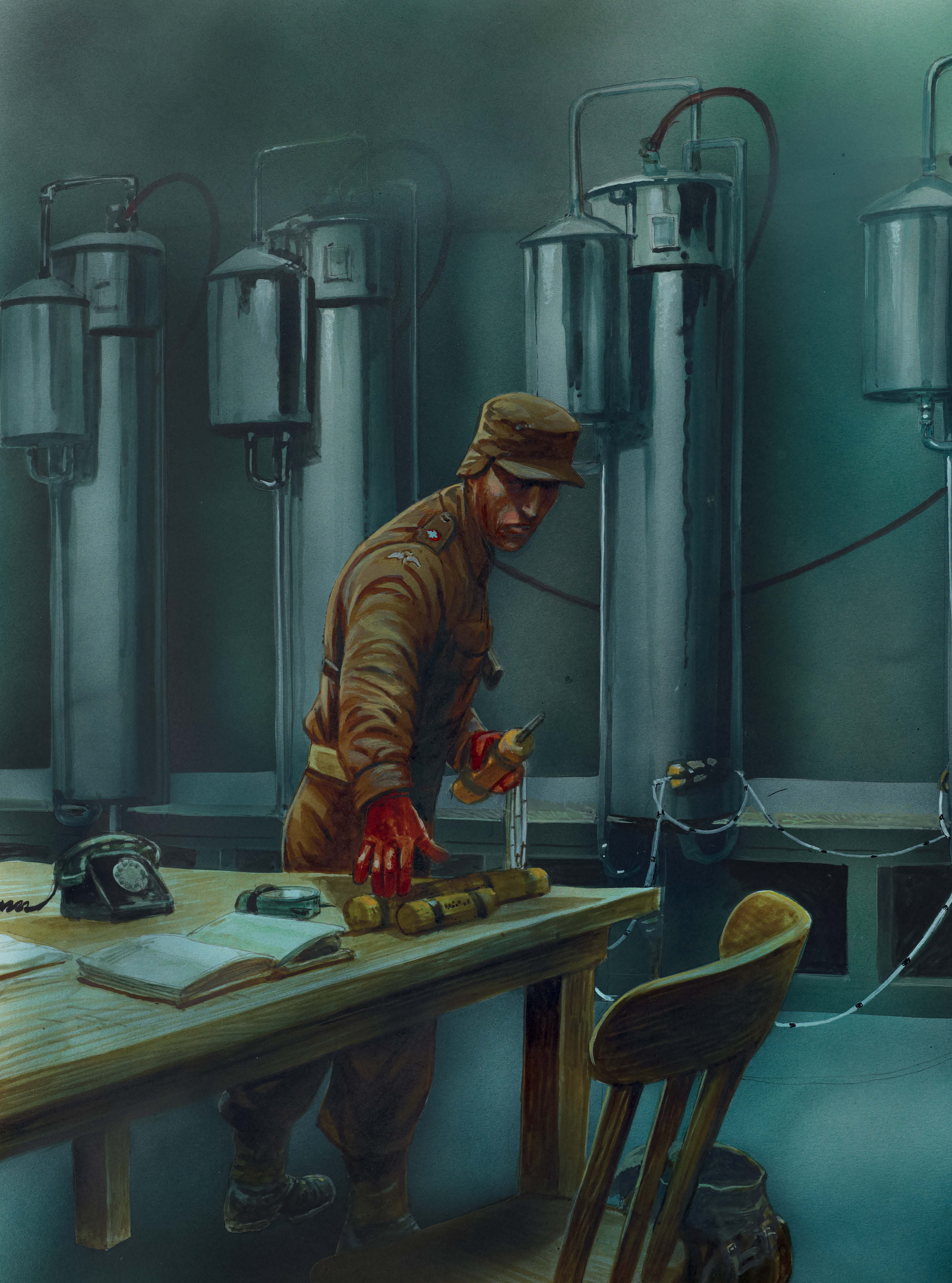


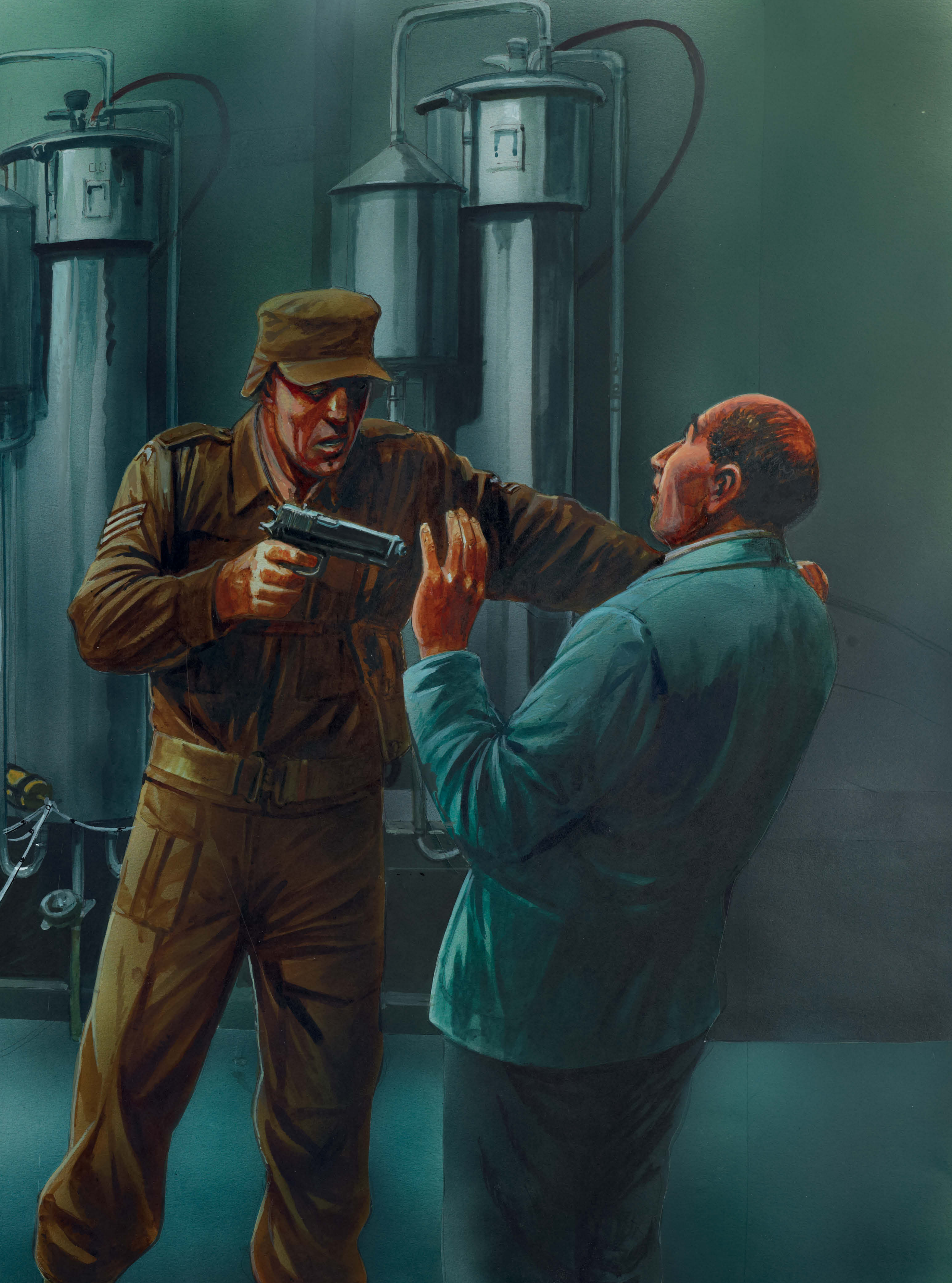
Kayser passed the pipes, his pistol slipped from its holster and made a clattering sound, but Rønneberg observed that the worker heard nothing. Crawling forward they reached a hole 10ft above the basement floor that led to a room adjacent to the cells. Rønneberg lowered himself down. He swung the door to the room that housed the electrolysis cells – marked with a notice saying NO ADMITTANCE EXCEPT ON BUSINESS – wide open and the worker was completely taken by surprise, having to remove his glasses to bring the soldiers into focus. Kayser demanded to know where the key to the yard was and the worker handed this over before being led at gunpoint to stand against the wall. Kayser asked the worker his name – Gustav Johansen he replied. Kayser said they were British soldiers. Rønneberg locked the door to the room and, dragging the table over, laid out his 20 nitrocellulose charges. Each was 12in long and had a detonator 120cm long.

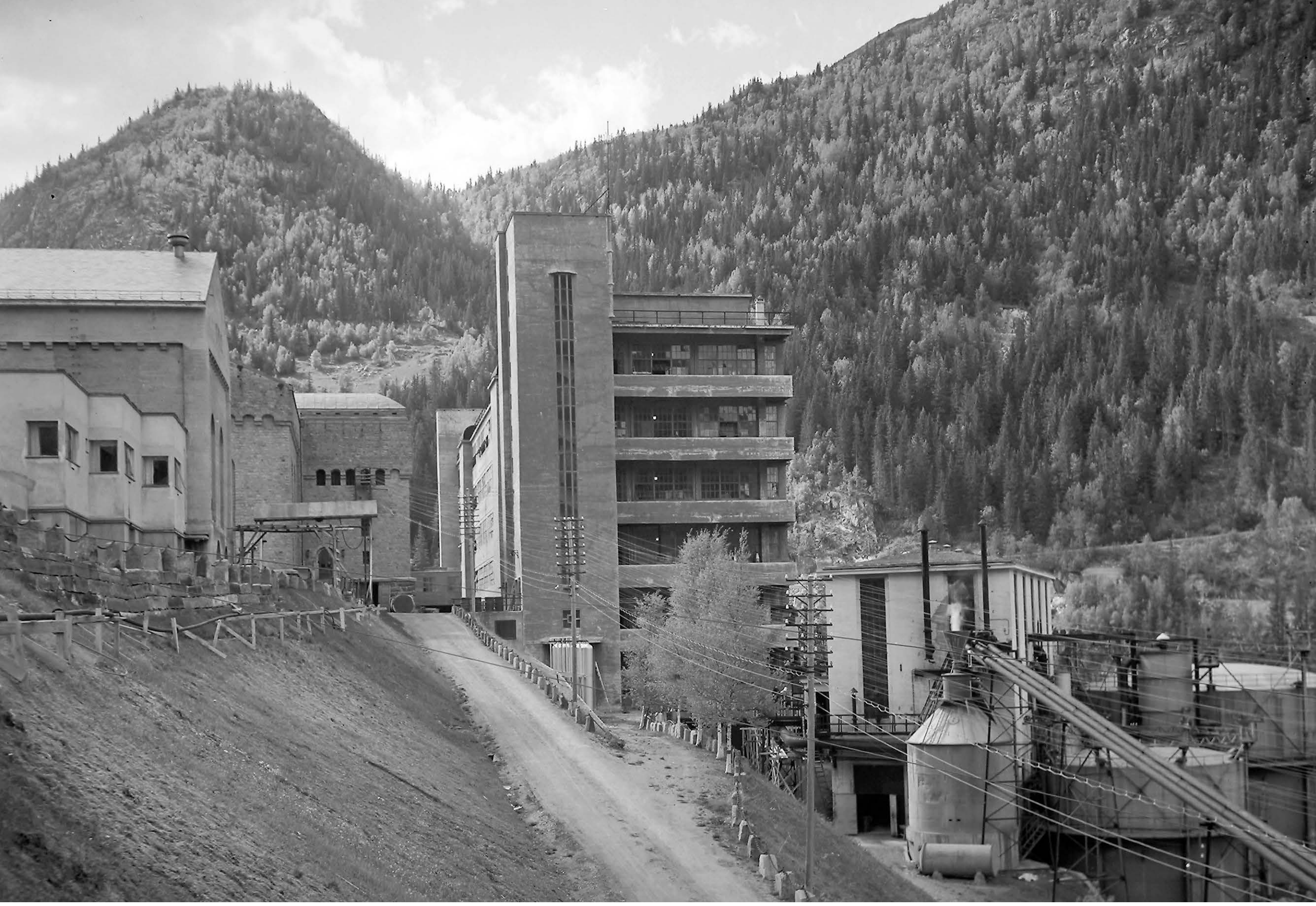
There were three methods of approaching the plant: to climb the cliff from the base of the gorge, to descend from the penstocks, or go along a railway hewn from the slope that went into the plant. The Germans had mined the area around the penstocks; placed MGs at the valve house at the upper end of the penstocks; and laid tripwires on the steps leading down to the penstocks. (Norsk Industriabeidermuseum. Foto: Gundersen, Asbjørn Kåre)

Destroying the electrolysis cells (overleaf)

Two of the raiders – Rønneberg and Kayser – have gained access to the electrolysis cell room in the basement of the Vemork plant through a cable duct. The Norwegian worker on duty, Gustav Johansen, is taken by surprise. Kayser had demanded to know where the key to the yard was and the worker handed this over. Kayser said they were British soldiers. Rønneberg locked the door to the room and then started to lay the charges. The 18 cells were 4ft 2in long and 12in diameter. Nine are on each side of the room. Rønneberg has brought 20 nitrocellulose charges. Each was 12in long and had a detonator 120cm long. There were also two 30cm fuses that would detonate all the charges; the longer fuses were kept as insurance if these did not work. Both are wearing battledress with white snow gaiters; they carry Colt .45 pistols.







When Rønneberg's men entered the gate and headed down the railway line the plant building loomed large in front of them. Here is their view of the side of the building; Rønneberg and Strømsheim could use the path around the building as the snow had recently been cleared and was heaped against the side of the wall. (Norsk Industriabeidermuseum. Foto: Ukjent)

Sabotage

The 18 cells were 4ft 2in long and 12in diameter, exact replicas of those they had practised on. The explosives fitted around the cells perfectly; Rønneberg attached them below the water jacket, the most vulnerable part. Johansen warned him of a caustic leakage. As the ninth charge was laid there was a crash of glass and Kayser nearly pulled his trigger when he recognised Strømsheim at the window. He and Idland had not found the cable duct and decided to break in. Rønneberg stopped what he was doing and went over to help Strømsheim through, telling Idland to stay outside to cover the opening in order to prevent any light from shining out of the basement, and guard the door. Rønneberg began to couple the fuses in order that only nine would need to be lit to set off all 18 charges. Strømsheim laid the charges on the other cells. Eight of the fuses were 120cm long, but the ninth was 30cm – Rønneberg would light this last. The shorter fuse would detonate all the charges; the longer fuses were kept as insurance. The burn rate of the fuses was 1cm per second.

After checking the arrangement, Rønneberg told Kayser to unlock the door to the yard. This was in the other room and Kayser led Johansen over to open the door with his key. Opening the door a fraction to check there was no bolt, Kayser returned with Johansen to tell Rønneberg their escape was ready. Before Rønneberg could light the fuse Johansen called out that his spectacles were missing. He found the case and handed them over.

Johansen shouted out that they were not in the case and Rønneberg, putting out his second match, found them in the logbook on the desk. A third match was lit when Strømsheim heard a guard's footsteps from above. The match was blown out and Olav Ingebretsen, another nightshift worker, appeared at the door. Kayser was told to bring both workers and tell them to dash to the second floor the moment the fuse was lit.

The demolition party had already taken 25 minutes. Poulsson and Haukelid were still waiting by the storage tanks. Haukelid later reported that the covering team were all within about 16yds of the barracks. Storhaug was among some fir trees near the road leading to the bridge, observing the guards; he could hear them chatting. Rønneberg removed his gloves and ignited the 2-minute fuses and then lit the short fuse. He told Idland to get clear. After a few seconds Kayser released the workers and met Rønneberg and Strømsheim at the door. They were 65ft from the door when they heard the explosion, which sounded like a thud, and looking

Those SOE agents who stayed in Norway changed into civilian clothes following the attack on the plant. They needed to disperse. Haukelid and Kjelstrup loaded a sledge and headed to the west side of the Hardanger. The ability of the agents to travel long distances across the Hardanger and to operate in disguise increased their chances of survival. When Poulsson stayed a night in an inn he was disturbed by the local sheriff looking for the saboteurs of the plant. He was questioned, but his cover story – that he was on holiday – passed muster. His room was looked over but his gun was not discovered, hidden within his drying laundry. Here, Tronstad is seen in southern Norway in 1944. (Norsk Industriabeidermuseum. Foto: Kårvand, Ingelinn) back observed flames emitting from blown-out windows. They passed through the gate and climbed to the railway tracks. In his report Rønneberg wrote: 'For a moment I looked back down the line and listened. Except for the faint hum of the machinery, the same hum we had heard when we arrived, everything in the factory was quiet'. (Quoted in Gallagher, p.154) With 3,000lb of heavy water flowing down the drains, Rønneberg's team immediately took cover to see if the guards did anything.

Poulsson and Haukelid heard the explosion and observed a flame. The barracks door opened and a soldier with no helmet or rifle walked 50yds to the plant to see if the door was still locked. He did not react to the light from the basement and returned to the barracks. He reappeared wearing his helmet and with a rifle, and had a torch that he shone towards them when they were 19ft away. He was looking among the storage tanks where they were hiding and then changed his mind, looking again at the electrolysis building. Haukelid ordered Poulsson not to fire. Poulsson later thought the guard was thinking the snow had melted and set off a landmine by the penstocks. When he returned to the barracks they headed off to the gate. The covering party were calm in a tense situation and had shown great restraint.

Similar sounds to the explosion were heard by the guards when burners on the balconies in the building made a noise. They were called cannons by the Norwegian workers because of the way they kept the guards wary. Brun described how when 'a burner had been turned off and was to be put into operation again, it sometimes happened that the ignition started with a bang. Explosions with heavy bangs also happened occasionally when the flow of gas (hydrogen and oxygen) to a burner for some reason became sluggish'. (Quoted in Gallagher, p.155).

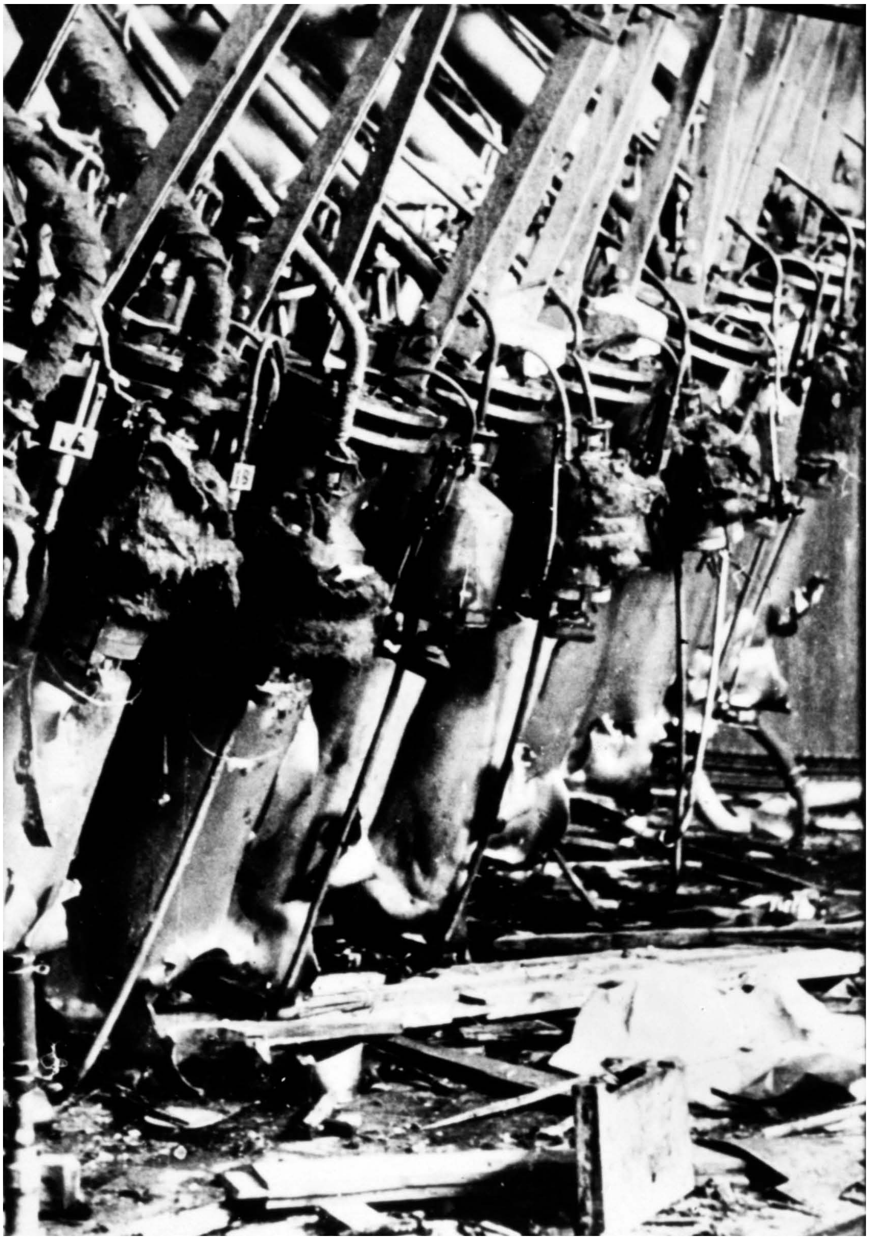
Escape

Helberg at the gate checked that the demolition party had gone ahead and Haukelid was the last out; he closed the gate and laid the chain and padlock in position. Helberg placed his Thompson on the ground by the track, to be found by the Germans as evidence the raid was done by British commandos. Gathered together 300yds from the gate, Helberg then found a different place to descend into the gorge. He jumped from ledge to ledge in a speedy descent. Once at the bottom they heard the sirens sounding. At the river the water had risen; a few hours later Rønneberg assessed the river would be too high. They then ascended the other side and were surprised that searchlights were not switched on to identify them climbing.

At the plant SS Untersturmführer Muggenthaler, the local Gestapo commander responsible for breaking resistance in Rjukan, arrived and Feldwebel Glaase, the guard commander, showed him the lock on the railway gate. Traces of blood were seen on the track (Rønneberg had cut his hand on the shards of glass while clearing the window Strømsheim had smashed). A trail through the gorge was discovered, but the storm had erased further traces of the raiders' route. Rediess arrived to look at the damage. Production had reached 330lb a month and was soon to reach

440lb. Rediess was furious and demanded to know how the sabotage had happened. He shut down the civilian telephone exchange and banned calls to workers at the plant. He was convinced workers from the plant had helped the raiders. His men arrested 50 and started to question them; ten prominent citizens of Rjukan were also seized and Rediess declared they would be shot if his questions were not answered. Roads and railway stations were closed in and out of the valley. Houses were searched; any fuse or explosive found was enough to make a farmer a suspect.

Oberleutnant Winkler, the adjutant of Wach Kompanie Rjukan, reported on the morning of 28 February that three men in uniform similar



In the electrolysis building Ivar Nass, an engineer on duty, described the blast: 'The explosion was tremendous; the power of it reverberated throughout the entire building. But outside, it may not have sounded like much, maybe like one of the "cannons" on the balcony. The building's concrete walls are very thick'. (Quoted in Gallagher, p.160) The chief engineer of the plant, A. H. Larsen, had heard the explosion from a home close to the main gate and phoned the plant. He spoke with Ingebretsen and was told that the cells were destroyed. He phoned his boss, B. Nilssen, who phoned the German garrison at Vemork. Larsen then went to the cell room to look over the damage. The cells had been ripped from the walls and torn apart by the blast. The heavy water had disappeared into the drains. (Norges Hjemmefrontmuseet) to the Norwegian Labour Service aged between 25 and 27 had entered the plant; two from the east, another through a window. They spoke Norwegian. Winkler thought they must have had local knowledge. The tracks of the raiders were followed just over a mile west, but as the night was stormy no further trace of them could be found. The garrison officers tried to establish how entry to the plant was established and why the security had failed.

Rediess reported to Berlin three soldiers were involved in the attack (the Thompson was found) and that they had gained access through the railway gate. He thought that Brun's disappearance was not a coincidence and that British Intelligence as well as the Norwegian Resistance was involved. Von Falkenhorst had arrived; he realised that the guards did not know how to switch on the searchlights and signed an order sending Glaase to the Eastern Front as punishment for his incompetence. He ordered roadblocks along the highway leading to the plant, larger minefields along the penstocks, and a doubling of the guard inside and outside the plant. Penstocks were to be camouflaged with 800 artificial trees and smoke-making equipment would be installed on both sides of the valley to protect against air raids. He ordered no reprisals and the release of all those arrested by Rediess.

Meanwhile, realising that their lives were in danger, the saboteurs started to climb the other side of the gorge. They reached the highway and noticed a car approaching. The headlights caught them, but the driver and passenger noticed nothing. Heading through the brush to the power line road, they also observed the headlights of trucks starting to leave Rjukan. Idland wanted to climb and avoid the road. Poulsson and Helberg advised staying with the plan. A majority decision agreed they should head off down the power line road towards Ryes Road. The power line road was in parts sheet ice; they sometimes used their skis. They passed other cars and trucks that were heading towards the plant on the main road below them, including a vehicle carrying Muggenthaler. Spruce trees and pine shrouded a four-hour climb that avoided the cable car base station, where no activity was observed, but each bend was in the open and they could be seen from below. The garrison was not thinking about how the group could escape and had not roused the cable car operator to send soldiers to the top. At 0500hrs the commandos were at the top and could put their skis on; they headed north-east, the snow was crusted and the skis made no impression.

On the plateau Rønneberg's team felt the worse of the weather. Ice carried by the wind hit the men as they struggled on. By late afternoon they had covered the 7 miles to a cabin by Lake Langesjå where they had a long rest. Rønneberg realised that no tracks were available for the enemy to follow and when they were forced by the storm to abandon their attempt to reach Fetter cabin the next morning, he knew they were safe to stay there until evening when they again headed out; this time reaching the cabin at 2130hrs on 1 March. Helberg had already departed to the cabin at Fjøsbudalen, to change into civilian clothes and retrieve his identity papers; he was to stay in Norway, as was Poulsson, Haukelid and Kjelstrup. When dawn arrived, he headed off to Fetter cabin to meet the others. Then

When Generaloberst von Falkenhorst arrived on 1 March he ordered the release of the hostages and berated the commandant, Hauptmann Nestler, for his lack of precautions in not having guards inside the cell room and at the railway gate. Glaase told Von Falkenhorst that floodlights were placed on the roof of the building but when Von Falkenhorst ordered them switched on the guard could not find the switch. The guard dogs were not on duty because of the foul weather. Here Von Falkenhorst is seen in the white coat with Terboven on the right of the picture. (Norges Hjemmefrontmuseet)

a storm hit at 0700hrs on 1 March, wrenching the map case from him; without this he had no chance of finding the cabin, so he headed off to the village of Turifit. Slushy snow had frozen, making the surface slippery. Helberg had not arrived at Langesjå when the storm had abated and the rest had already departed. By 2000hrs on 3 March they reached their HQ hut in Skrykken at Jansbu, where the rest of their supplies were hidden.

On 4 March Rønneberg, Idland, Strømsheim, Storhaug and Kayser prepared their rucksacks and started on their approximately 250-mile trek to the Swedish border that was predicted to take ten days. They stayed wearing their uniforms and were hauling a toboggan. The following night they broke into a cabin on Lake Rodungen; then they spent a night in a farm at Nyseter. The next day they stayed in, concerned that they would meet weekend day-trippers. A skier went into a neighbouring hut 10yds from theirs and they hid to remain unseen. They headed off the following evening and crossed the River Hallingdal by finding a stretch that was still iced over. That night they had to sleep out, with wet clothes because of the river crossing, but found their sleeping bags to be sufficient. The next morning they found a hut in which to dry their belongings. They made better progress as they had ditched their toboggan and found a farm that was unoccupied, but contained basic food provisions.

On 10 March they headed out and two men passed them and waved, assuming Rønneberg's men were Germans; weapons were seen in the rucksacks Rønneberg's men were carrying. That night they crossed Aurdals Fjord, again by finding a stretch that was still covered with some ice. They covered less distance than they thought because warmer weather had caused the snow to start melting, and rations were dissipating quicker than they had anticipated. They made every effort to find huts that had supplies. Then the weather was colder and better progress was made. They slept outside for two nights as they could not find an isolated hut. On 16 March they approached the River Glomma, but were lost in the lowlands and could only find the river that night; they used a boat to cross because the ice on the river had melted. The following night was spent in sleeping bags. At 2015hrs on 18 March they crossed the border into Sweden. They dispensed with their uniforms and pretended to be labourers that had escaped from a German camp in Dombass. They departed Sweden by boat on 28 March and the next day they were in London.

On 4 March Poulsson, Haukelid and Kjelstrup had changed into civilian clothes. Haukelid and Kjelstrup were to establish a base to organise resistance cells in the northern part of the Slettedal and stop off to see Skinnarland and Haugland. Poulsson, armed with a Norwegian pistol and with Norwegian money, ID card and passport, along with Helberg, headed off for Oslo via the Uvdal Valley, but they took separate routes. On 8 March

On 18 March the Germans began a sweep of the Hardanger over a 350-square-mile area. Soon the news agency in Oslo was reporting 800 British troops were engaged in a battle on the Hardanger with a force commanded by Rediess. Here, German soldiers muster in southern Norway. (Photo by ullstein bild/ullstein bild via Getty Images)

The Germans were making too many ski tracks because they had too many men. They could not distinguish between their own and other tracks that the saboteurs might have made. Many of the soldiers that were gathered to launch the search for Rønneberg's men were inexperienced skiers. (Photo by Bernd Lohse/ullstein bild via Getty Images)

Poulsson was in Oslo standing by the Majorstuar Café, waiting for Helberg. He had not shown the previous day, but this time he was there. Helberg had skied to Geilo and taken the train to Oslo. They discussed whether the Germans were looking for them at Uvdal. They wondered whether Kristiansen had told the Germans about them; unbeknown to them he had spent the week hunting on the plateau, but when he returned to Uvdal he had given some chocolate that Poulsson had given him to a local child. This was reported to the sheriff and Kristiansen was questioned by the Gestapo about where he had obtained the chocolate. His rifle and ammunition were discovered in his house. He admitted that British soldiers (rather than Norwegian) had captured him near Lake Skrykken. Rediess headed to Uvdal and was soon joined there by von Falkenhorst and Terboven. Papers published in Sweden had suggested that the raiders had escaped by plane landing on a frozen lake. They decided to launch a search of the Hardanger Plateau, convinced that the saboteurs were still there.

At Skårbu Haukelid and Kjelstrup had made contact with Haugland and Skinnarland and on 10 March Haugland radioed London of the raid's success. The search for them had started. Rønneberg was by then at the north-east corner of the plateau. Haukelid and Kjelstrup had gone as high as they could to avoid the German search parties. Haugland and Skinnarland stayed in their tent near cabins lower down and made use of information supplied by Jon Hamaren and Olav Skindalen. Skinnarland knew both families and they supplied him with food and fuel with which to cook. They observed German patrols going to Lake Møs and reconnaissance aircraft that could not spot them. In all, 7,800 men were assembled, including Norwegians from the Konsvinger Battalion and Jagdkommando platoons. A travel ban on the plateau was instigated. Curfews and travel passes were introduced in Rjukan and the surrounding towns.

Helberg, after two weeks in a safe house, received a note from Sørlie saying that he could return to Rjukan. He took the train to Uvdal and planned to ski the 30 miles to the cabin at Jansbu to retrieve weapons and explosives hidden there, as he intended to join the resistance south-east of Rjukan. He had heard nothing about the German raid, and everything looked normal as he set out across the plateau on skis. He reached the cabin on 25 March and found the door unlocked. He went in and found a mess – a search had occurred. He went outside and half a mile away noticed some Germans approaching on skis. He was spotted and tried to out-ski them. He headed into the sun and three Germans starting to shoot kept missing him; an hour went by with Helberg skiing through ravines, over hills, and over cliffs; nearly 10 miles into the pursuit two of his pursuers, by this time exhausted, began to lose ground. The fittest German was still continuing and Helberg realised he was faster going downhill. He tried to find hills to climb in order to gain distance 'until finally I went as high as I could and there were no more hills to climb, only hills to descend. I started down, pushing off with all my strength, trying to use every twist and turn to my advantage, but after about a quarter of an hour I could hear his skis and poles behind me'. (Quoted in Gallagher, p.192)

The German probably did not realise that Helberg had a gun and told him to raise his hands. He wanted to bring him in for questioning. Helberg turned and a pistol duel at 40yds was carried out. Helberg fired only once and then let the German fire all the rounds in his magazine. He knew how difficult aiming in this environment would be with the sun shining in his eyes. He decided to stay still and all the bullets passed by, some closer than

After the German search for the saboteurs had petered out Skinnarland received training from Haugland on the radio. Skinnarland had only received two days in the STS and was a long way from the standard required. Haugland built an improvised radio set in a remote hut where they knew they would be safe; hidden and inaccessible, like the hut Tronstad used, seen here, when he returned to southern Norway in 1944. (Norsk Industriabeidermuseum. Foto: Kårvand, Ingelinn) others. The German then started to climb the hill and Helberg was the pursuer, intent on stopping him before he could reach help. Just before the top of the hill Helberg aimed and from 30yds fired several shots. The German staggered and crumpled onto his ski poles.

Continuing on in the dark Helberg decided to go to Lake Vråjoen, where the ice would conceal his tracks. On his way there, two hours into the journey, he fell over a 120ft cliff into a snowdrift and broke his arm. His skis were not broken and, realising he needed medical treatment, he decided to ski to Hameren's farm on Lake Møs at Lien. He reached it at 0800hrs and was told that German search parties were at the neighbouring farm; he decided to carry on to Rauland, 20 miles south.

Outside the town he was stopped by a German patrol and had to show his papers. He used a cover story that he was helping with the search and was wounded. If his pistol was discovered he would tell them that he was allowed to carry a gun in case of trouble. In Rauland he discovered that Rediess and Terboven had recently inspected 300 troops and Gestapo agents were still there. The weather had improved and he went to a shopkeeper he knew and slept on his floor. The bedrooms in the house were occupied by German officers. The next day he approached a German NCO and volunteered to join the search for the saboteurs; the NCO offered to have a German army doctor look at his arm. He undressed and put the gun in his jacket. He was bandaged and given something for the pain. The doctor made arrangements to take him by ambulance to Dalen 22 miles to the south, from where he was to make his own way to hospital in Oslo.

At Dalen he found a room in the Bandak Tourist Hotel, prior to taking the boat for Oslo; he had to hide his gun when a commotion down at reception announced the arrival of Terboven; his entourage was requisitioning rooms and every person that was staying had to show his ID card and state the purpose of his visit. Helberg's papers were in order and he was allowed to stay in his room. He wanted to escape and went to the lounge, but guards were asking everyone why they were leaving and he decided to sit and bide his time. He was moved from a chair that was reserved for Terboven and went to the dining room and used a small table that was inconspicuous. Terboven with others then appeared and sat at two large tables by the fire; he asked a Norwegian girl, called Åse Hassel, to join him; at first she refused, but eventually, with little enthusiasm, moved to his table. She spoke perfect German and said her father was a senior officer in the Norwegian Army in England.

Maintaining skis was very important. Soon after his return to the Hardanger, Helberg was forced to ski cross-country in order to escape his pursuers. Here, Tronstad is seen working on his skis in Norway in the winter of 1944/45. (Norsk Industriabeidermuseum. Foto: Kårvand, Ingelinn)

At Dalen Helberg wanted to board the bus last in order to obtain a seat close to the door, but his reluctance angered a guard and he was kicked down the hotel's steps. Although he did not refer to the incident, there are reports that his gun fell out. Helberg thought he would be shot or at least questioned there and then but the guard eventually decided to leave this to the officer at the camp the bus was taking him to. Helberg had a tendency to find himself in risky situations but used bluff to get out of trouble. (Norges Hjemmefrontmuseet)

The next morning at 0500hrs a Gestapo officer knocked at his door and ordered him to go to the lounge. At 1030hrs 18 guests, including Hassel and Helberg, were ordered to pack and be ready in 10 minutes; because of their impertinent attitude they were being arrested. They were to be taken to the German prison camp at Grini for questioning. Instead of saying he was part of the search for the saboteurs, Helberg thought there 'would probably be less risk going along in the bus with the other prisoners. The ride to Grini would take many hours; the bus would have to stop along the way; I could escape. I certainly could not stay with the transport all the way to Grini not with my gun tucked away inside my ski jacket'. (Quoted in Gallagher, p.200) While waiting, he observed Terboven leave and then the bus arrived. He was the last to board and was forced to sit on the floor, as all the seats were taken.

There was an SS guard with rifle and grenades on the bus and two motorcycles with sidecars with another two soldiers, one in front and one to the rear. Helberg was sitting close to Åse Hassel and he started talking to her. They were both laughing and this attracted the attention of the guard; he suggested that Helberg sit at the front as he had an injury. Åse spoke with the guard in fluent German. Helberg, out of sight of the guard, made signs to the girl that he was going to try and escape. Hopefully she would distract him. The bus driver controlled the door by a lever. Helberg described how:

> The Norwegian driver paid no attention to me. He kept his eyes on the road and maintained the same speed as the lead motorcycle, which continued at a steady pace about fifteen yards ahead of us. The motorcycle in the rear maintained the same speed from about the same distance, so there would be very little room for error when I made my move. (Quoted in Gallagher, p.203)

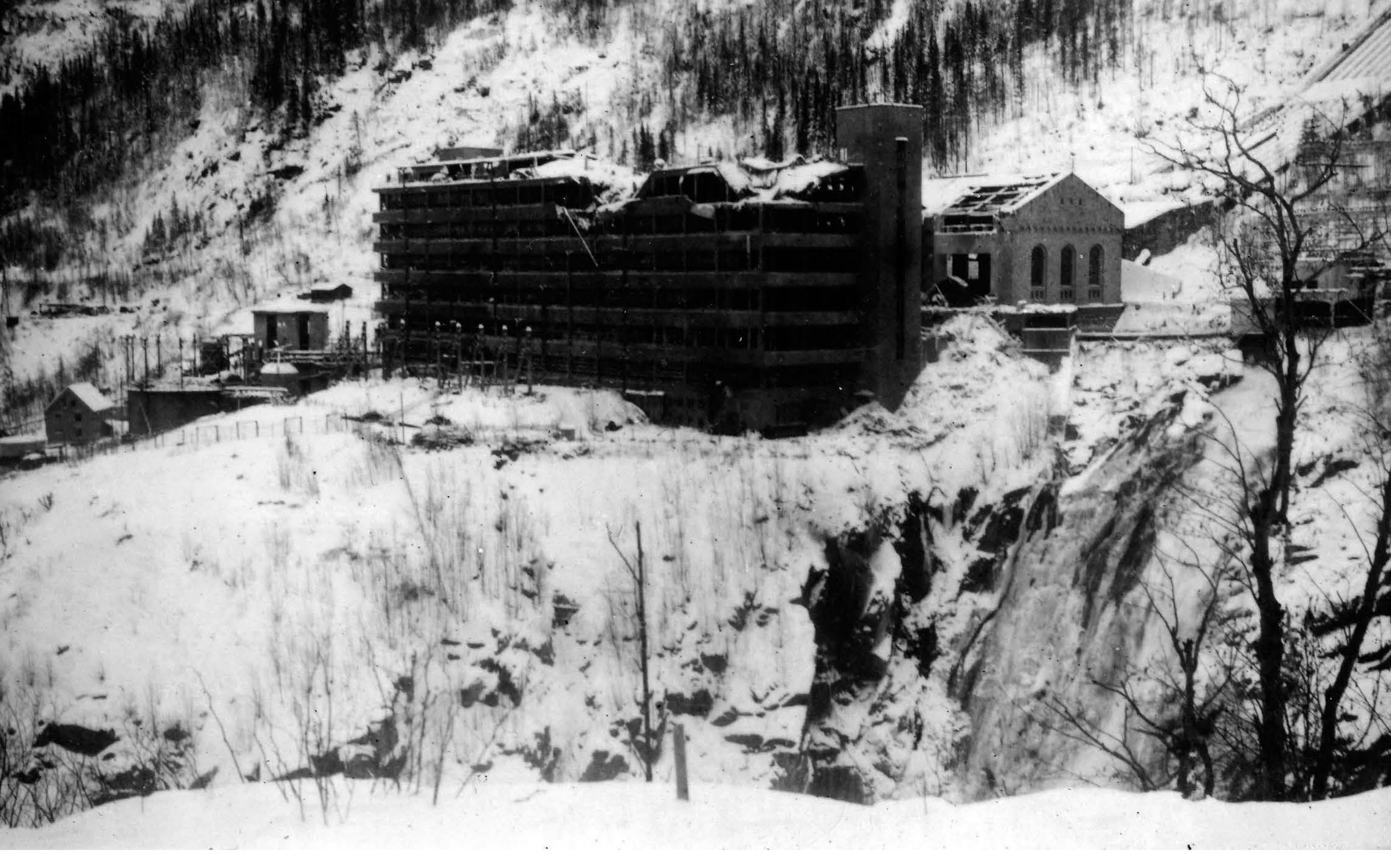
He had to wait for the bus to approach a stretch of road that had some roadside cover and ideally a bend that would slow the bus down. They were climbing a hill that was about 30 miles from Oslo, and at the top of the hill the woods were close to the road. He jumped over to the driver's seat and pulled the lever. The brakes screeched, bringing the bus to a stop. The motorcycles had also stopped. Helberg started over the fields to the woods and heard the crack of rifle bullets. He was altering his speed and zigzagging to put them off. He tried to get into the woods, but was prevented from reaching the cover they offered by a fence; he heard a grenade explode as he reached the obstacle and he had to return to the road. He went between the bus and a motorcycle sidecar and then over a field on the other side. A third grenade that was thrown hit him and he thought he had no chance, but there was no explosion. The guard had pulled the pin out too early and there was an explosion soon after, but by that time he was out of the blast zone. From good cover in the pine woods he could see all five guards searching for him before returning to the road. Embarrassed that Helberg had escaped, they would tell the other passengers and the officer at Grini that an escaped captive was shot and mortally wounded. With the bus driving on, Helberg had to ask for help. A farm was close by and he knocked on the door. The farmer called a Norwegian doctor and he was taken by ambulance to Drammen hospital. Staying there for three weeks, he gathered his strength and some skis that enabled him to make his way to Sweden via Oslo. He boarded a plane for the UK on 2 June.

Back on the plateau Haugland signalled London that the Germans behaved like hooligans, shooting reindeer and burning huts, and reported information from agents in the plant about the results of their attack. Along with Skinnarland he had vacated a hut on Lake Møs called Nilsbu on 24 March and gone higher to avoid the patrols. On 1 April they returned to Nilsbu. German D/F vehicles were looking for them, but were usually stationed on Lake Møs, too low to intercept their signals. Haugland also knew from a contact that the German D/F station commander thought the radio operator was based in Rjukan or an outlying village. On 16 April the Hamarens warned that the Germans had returned. Haugland was to make for Oslo to help the resistance while Skinnarland stayed on the plateau. Haukelid was also in Oslo in June and with Kjelstrup departed the city with new ID cards; they posed as tourists on the Hardanger. They built a cabin in a remote location and visited Skinnarland at Nilsbu. Kjelstrup had to depart in September to Sweden because his health was deteriorating.

Air raids

The Germans started to repair the heavy water facility. In April 255lb of heavy water was sent to Vemork to help return the plant to full production. Muggenthaler was in charge of security. Guards were placed near the railway gate. Mines were laid, fences raised, all doors to the plant bricked but for the main entrance, all windows blocked. German technicians were introduced and would spy on the Norwegians. Heisenberg and Diebner were using different machines to break the atom and their need for heavy water grew. On 8 July Skinnarland reported Vemork was expected to reach full production by 15 August. On 19 July Tronstad wrote a report for SOE that recommended targeting shipments, sabotage from within, or hitting sites in Berlin. On 3 August Skinnarland reported that 9lb were being produced per day, but the following week stated that putting oil into the distillation vats had at times reduced this to 3lb. He also suggested attacking the shipments.

Lord Selbourne, the Minister in charge of SOE, spoke to Churchill and the destruction of the plant was again given the highest priority. The US General Leslie Groves suggested that a bombing raid was necessary.



The Norwegian government in exile, given no warning of the air bombardment of Vemork, protested and recommended sabotage operations. Tronstad was not told of the plan to mount a strategic bomber raid and was embittered when he discovered that the attack was made. Damage to the plant was light with the top floors of the electrolysis building, seen here, only receiving hits. Brun was furious; he was persuaded by Tronstad not to resign from the Tube Alloys Committee. (Norsk Industriabeidermuseum. Foto: Kårvand, Ingelinn)

Tronstad and Wilson opposed the idea, but the Combined Chiefs of Staff concluded that the objective was better suited to bombing than sabotage, because of the security measures in place. The head of Norsk Hydro had threatened to shut down the plant when the fertiliser plant at Heroya was destroyed by bombers; without the fertiliser plant working hydrogen gas would have to be released into the air at Vemork. He was arrested; a new head took his place.

Tronstad wanted Vemork taken off the target list, but A. R. Boyle, chief of Air Ministry Defence Intelligence, told SOE that Vemork should be struck. On 18 August Peenemünde, the research facility that produced flying bombs, was hit and the Tube Alloys Committee wanted a similar operation at Vemork. On 20 August SOE suggested that the bombing of Vemork be given active consideration by the Chiefs of Staff. On 16 October a War Cabinet memo to SOE and Combined Operations ended all hope of a sabotage attack; a daylight raid by US bombers was proposed. The Allies thought from aerial photographs of the Haigenloch–Hechigen area that the Germans were building a nuclear reactor capable of making fission products and that the importance of heavy water justified the risk.

On 16 November 1943, 388 B-17 Flying Fortresses and B-24 Liberator bombers were committed to the raid; some attacked an airfield north of Oslo to distract German fighters while others went for industrial sites at Knaben. The aircraft destined for Vemork were ahead of schedule, so they delayed by 22 minutes. They were intercepted by German fighters, but these were too few to cause many losses. A total of 176 B-17s reached Vemork at 1133hrs. 100th Group could see their targets, even though smoke generated in the valley started to drift. In 45 minutes, 700 1,000lb and 200 500lb bombs fell in the valley.

Smoke was being emitted from the generators installed after the sabotage raid, which hindered the aim of other aircraft participating in the raid, so most bombs failed to hit their target; one hit a shelter and 16 civilians were killed. Eighteen bombs hit Vemork in total. Four bombs hit the power plant, but the machinery suffered little damage. Five buildings were destroyed and four barrack huts. Three bombs hit the penstocks and the sluice gates automatically shut; although they were struck by two bombs no water cascaded into the plant. The suspension bridge and the rail tracks were damaged. Two bombs hit the electrolysis plant, but in the basement the heavy water cells were undamaged.

The air raid had a positive effect in that the Germans were convinced that the plant was in severe danger, so they decided to move all heavy water and production equipment to Germany. Walther Gerlach had taken charge of the project and was supporting Diebner rather than Heisenberg. Ballistic missile technology was improving and the operational deployment of V-2 rockets, which could not be intercepted, was anticipated. Skinnarland, operating the radio on the Hardanger because Haugland had gone to Oslo, found out about this movement, as Gunnar Syverstad worked on heavy water production figures. He was told by SOE to pass on the need to contaminate the water with oil. Sørlie visited Skinnarland and was told to find out about the shipments.

16 NOVEMBER 1943

A massive B-17 and B-24 air raid hits Vemork

The B-17s reached Vemork at 1133hrs; at lunchtime to mitigate the threat to the workers at the plant. Sirens alerted the workers and civilians. The cloud was low and 95th Group could not identify their targets. Here, B-17s are seen on their approach to targets in Norway. (Norges Hjemmefrontmuseet)

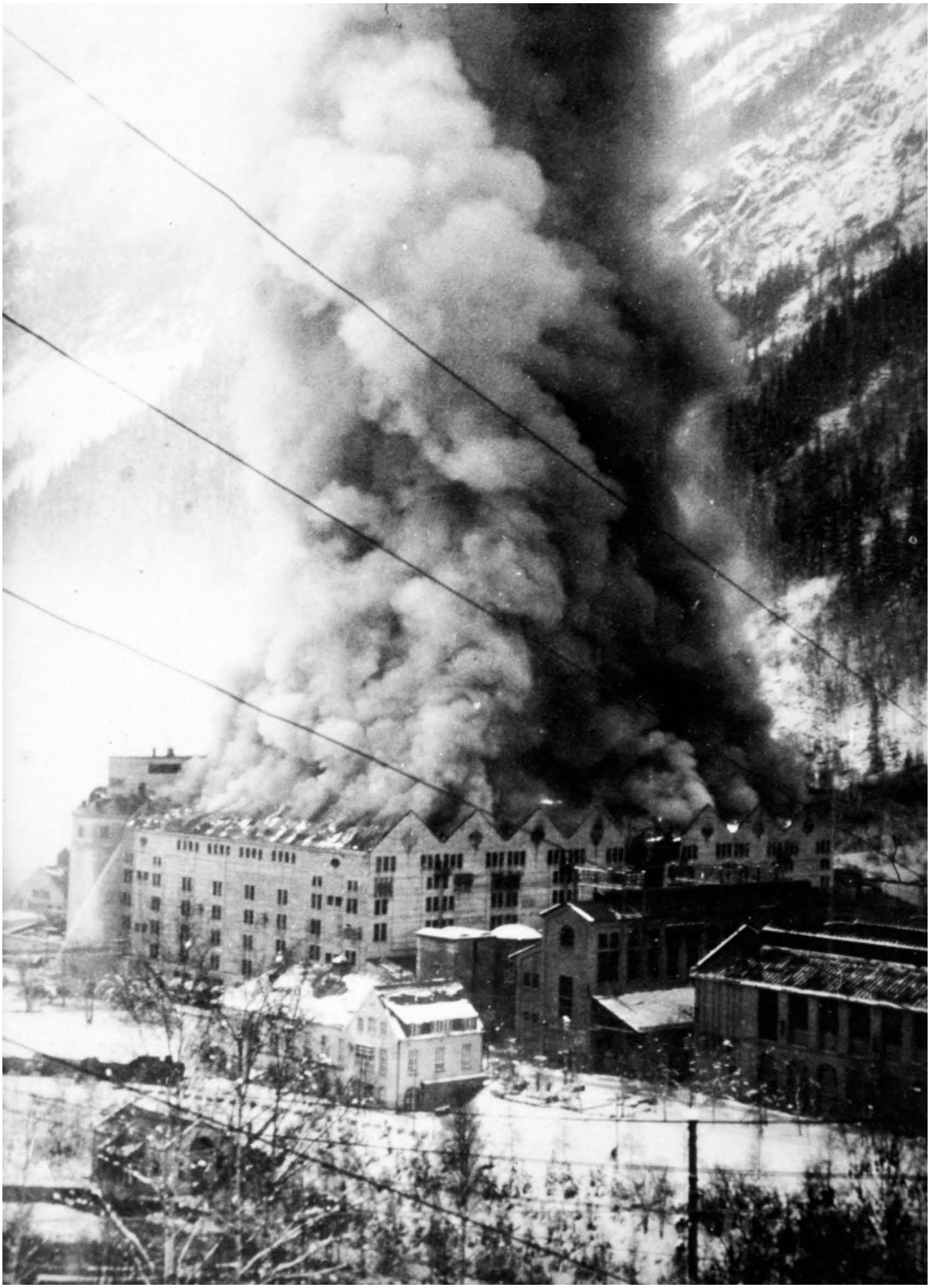
The *Hydro*

At the end of January 1944, Skinnarland sent a message confirming that the heavy water processing equipment was to be taken to Germany. However, on 3 February Skinnarland did not know when or how the shipments would begin. Rolf Sørlie met with the engineer responsible for organising the shipping of the heavy water, Kjell Nielsen, in Rjukan. Nielsen told him that the heavy water was to be placed in drums and taken to the rail ferry at Mael, where they would be taken across Lake Tinnsjø. Then the drums would be moved to Notodden and then to a ship in Menstad. Nielsen suggested that the heavy water would be difficult to use because the concentrations were uneven, and he thought the operation to destroy the shipment would only risk reprisals on civilians. On 7 February Skinnarland told SOE that the removal would occur within a week. Tronstad was asked what should be done and he referred the matter to the Norwegian High Command and the War Cabinet. On 8 February approval was given for the attack; the destruction of the stocks was a top priority.

At the end of January Haukelid had gone 30 miles from Rjukan and was in the west of the Hardanger. He had returned to meet Skinnarland and Sørlie at Nilsbu. On 9 February Skinnarland and Haukelid recommended derailing the train into the gorge. On 13 February Haukelid and Skinnarland stayed at a cabin at the top of the Krossobanen cable car. On 15 February they were introduced to 67-year-old Ditlev Diseth and then met Syverstad and Nielsen in Rjukan. Diseth was a retired worker from Norsk Hydro and owner of a clock repair shop. On 16 February Tronstad was asked whether the operation was worth the risk and he told them to carry on.

On 17 February Haukelid and Skinnarland visited Larsen and were joined by Nielsen and Sørlie. They discussed the best way to intercept the heavy water – with guards controlling entry to the electrolysis building, destroying the 39 drums stored at the plant was ruled out. They could attack the 2½-mile-long rail track from Vemork to Rjukan, and there was a shack by the track that stored Norsk Hydro's 2 tons of dynamite. The railcars and drums of heavy water would be blown into the valley. There was a guard in the shack and stricter security measures might be implemented when the shipments were about to begin; also, civilian workers used the railway because the bridge was still down and they could be killed. The Germans would probably use the workers as a deterrent to any sabotage attack by having them as passengers when the drums were shipped. The planting of explosives on the train track onwards from Lake Tinnsjø risked the lives of civilians, as the route was popular all year round and tanks of ammonia, likely to be carried on the train at the same time as the heavy water, might be caught in the explosion. The other part of the journey – across Lake Tinnsjø – was then discussed. Haukelid decided to attack the ferry on 20 February when only a single crossing of the lake was scheduled. There would be fewer passengers at the weekend. They decided to attack the ferry on 20 February. Nielsen and Syverstad were told to delay the loading of the drums until then; both wanted to call off the

Opposite: B-24s assigned to the targets in Oslo approached, unable to release on their targets there; 15 bombers mistook the nitrate plant in Rjukan for the heavy water plant and targeted the site with 118 500lb bombs, breaking water, ammonia, gas, and steam pipes as well as destroying the packing plant and workshop. (Norges Hjemmefrontmuseet)



operation because of the threat of reprisals. The ferry would be sunk at the deepest point in the fjord, so the barrels of heavy water could not be salvaged. Because civilians would be on board, clearance for the operation was sought and given by the Norwegian government in exile. London also stipulated that the engines were to be put out of action to prevent beaching in shallow water. An explosion to indicate that a limpet mine on the outside of the vessel had been detonated and the presence of a British uniform, would suggest to the Germans that a commando attack had occurred.

Haukelid would obtain the explosives and taught Sørlie how to use firearms and grenades. Diseth proposed using alarm clock detonation. The strike of the hammer would close a circuit to provide an electric current to set off a detonator. Three men were needed for the attack and with Skinnarland reserved for operating the radio, a local resident called Knut Lier-Hansen was found to participate in the operation. Lier-Hansen, a 27-year-old former army sergeant, had a car and, as a surveyor, a permit to travel anywhere. He worked with the resistance, but he had returned to Vemork to work in the plant.

Haukelid reconnoitred the ferry site at Mael and established that the day the shipment was due to board, a steamer, the *Hydro*, was the ferry timetabled for the route. He took a trip to Tinnsjø and noted that *Hydro* took 30 minutes to reach deep water, where it stayed for 20 minutes at waters that had a depth of 1,300ft. He thought the explosives needed to go off 45 minutes after leaving Mael to give some leeway if the ferry was delayed or made good speed. Haukelid assembled the electric detonator device in Diseth's shop. They decided to plant the device in the bow in order to sink the front first and, by raising the stern, tilt the wagons with the heavy water into the lake. If the engines were still working with the propellers out of the water the ferry would still be unable to move.

They needed enough explosive to blow a hole in the ferry big enough to sink the vessel quickly but still leave enough time for civilians to abandon ship. They rolled 19lb of explosive into a 12ft-long tube and covered it in burlap to help with handling. This would make a 4ft wide hole. Diseth removed the bells from the alarm clocks and replaced them with an electric insulator from a telephone receiver; a small piece of Bakelite was attached to copper plates and these were connected to detonator caps that would go off when triggered by an electric circuit supplied by batteries. The bell hammer would strike the copper plates and complete the circuit. The electric current would activate the percussion caps and the explosives would be set off. Four batteries powered the device. Haukelid, with Sørlie, that night went back to their hut and tested the device. The next morning they were awoken by two loud cracks as the percussion caps went off. Following the operation Haukelid would go to Sweden and return to London, Syverstad would join the resistance, Lier-Hansen would return to his surveyor's job and Nielsen would arrange to be in Oslo, receiving medical treatment. Haukelid decided that Larsen, the chief engineer, would depart for Sweden in order that the Germans had someone to blame. On 19 February they went to Rjukan to meet the others.

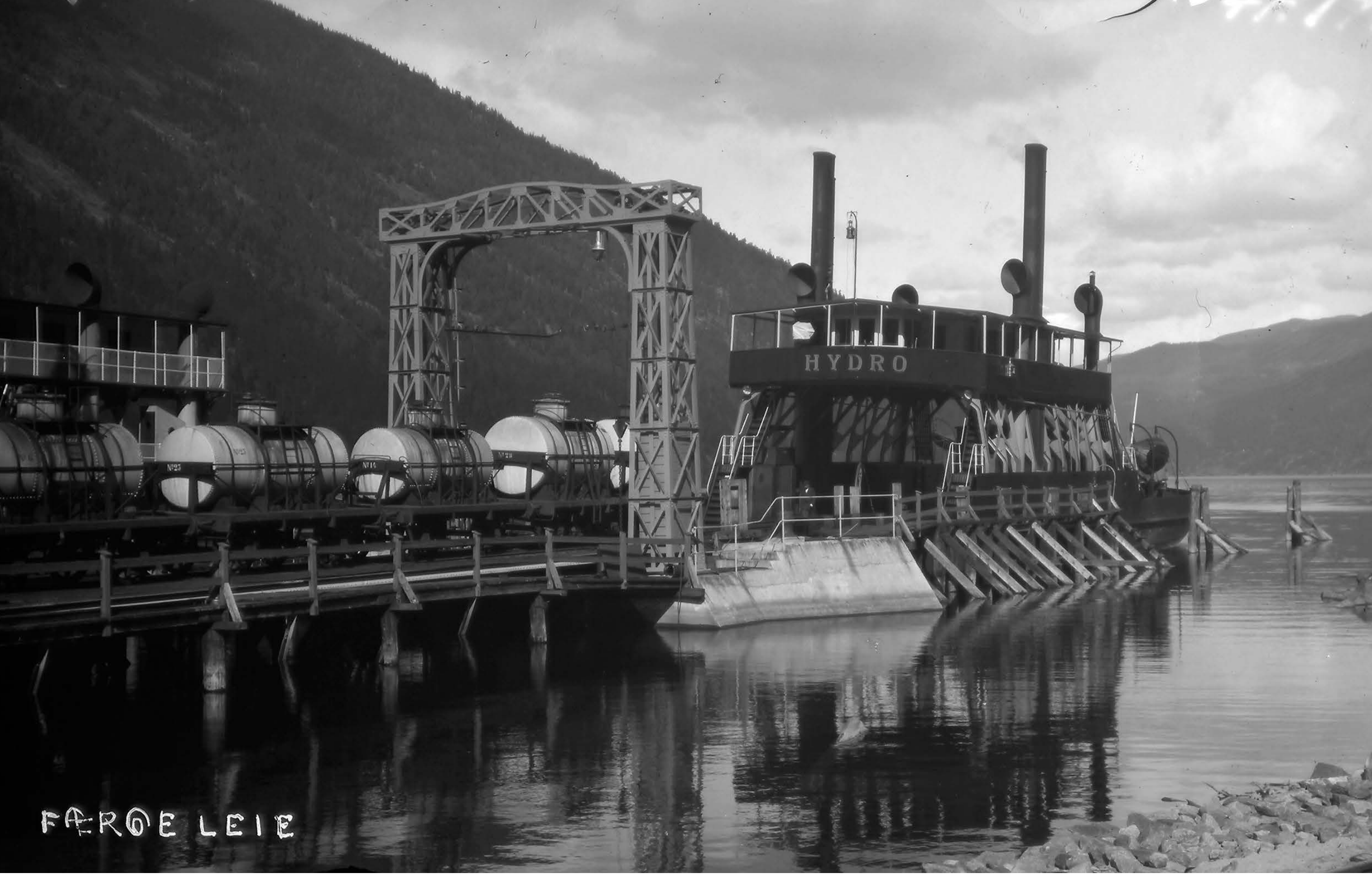
CÔTÉ DE L'OCCIDENT

In July 1943 the *Gunnerside* team and Tronstad received awards for their achievements. Tronstad received the Order of the British Empire, Rønneberg and Poulsson the Distinguished Service Order, and others either a Military Cross or Military Medal. Here are Haukelid, Poulsson, Rønneberg, Kayser, Kjelstrup, Haugland, Strømsheim and Storhaug. (Norges Hjemmefrontmuseet)

The rail wagons were under constant guard; troops from 7th SS Police Regiment appeared in the Rjukan Valley. The local resistance had reported that the Rjukan telephone exchange had heard a call between two enemy commanders that discussed how a most fantastic sabotage attempt was about to be attempted. Precautions taken by the Germans were high. On 18 February the drums were loaded onto the railcars. Army units were placed along the railway route all the way from the plant to the rail siding by the ferry terminal. Two Fieseler Storch planes flew sorties over the local area close to Rjukan; however, the ferry, while waiting at Mael, would be unguarded and vulnerable.

Haukelid needed to know when the train would arrive at Mael. The night before the railcars were due to be loaded, Haukelid would creep on board the ferry and leave explosive charges in the bilges, with alarm clock detonators programmed to go off the next morning. Nielsen confirmed that the drums were loaded onto railcars and Lier-Hansen talked to the conductors and railway personnel and was told that they would depart on Saturday 19 February and travel to Rjukan, where they would stay until moving on to Mael early on Sunday morning. The ferry would be docked in Mael on Saturday night.

On Saturday night Haukelid and Sørlie went to Rjukan from their hut and observed two flat railcars loaded with drums in the village, under floodlights and surrounded by guards. Forty-three 400-litre (87.9-gallon) drums and five 50-litre (10.9-gallon) flasks with the highest concentrations of heavy water, in total 5,000 gallons, were on the railcars. The flasks would be taken off the railcars after the ferry crossing and taken by truck to



The drums with the heavy water could be targeted in Vemork. The railcars would be pitched into the gorge but some might be undamaged and if guards were killed then reprisals would result. Alternatively, the ship used to carry the drums could be attacked at the port of Menstad or at sea. The best plan was to attack the ferry on Lake Tinnsjø. Skinnarland informed Tronstad of their decision. Tronstad also planned a limpet mine attack in Menstad and interception of the ship at sea by aircraft. Here the ferry *Hydro* is seen at Mael on Lake Tinnsjø. (Norsk Industriabeidermuseum. Foto: Ukjent)

Notodden, Larsen told Nielsen. Lier-Hansen had asked Olav Hansen in Rjukan to drive them to Mael in a car because he told him he needed to move his surveyors' instruments; no questions were asked as Hansen frequently helped him.

Initially the car would not start (the carburettor was full of soot), but at 0100hrs on 20 February they eventually got going and Olav Hansen drove them 7¼ miles to within three quarters of a mile from the ferry dock at Mael. Haukelid wanted Hansen away from Mael and Lier-Hansen took him back to Rjukan. He was told they had to travel on to Tinnsjø and Olav agreed that his car could be used. Lier-Hansen returned to Mael. There were no floodlights illuminating the ferry or the station and no guards were seen. Lier-Hansen had observed earlier in the week 20–30 guards in the station (there was actually 15–20), but he had noted they kept inside their barracks and rarely ventured out. Haukelid gave Larsen a pistol, told him to wait at the car for two hours and if they did not return he was to go to Oslo by train and head for Sweden.

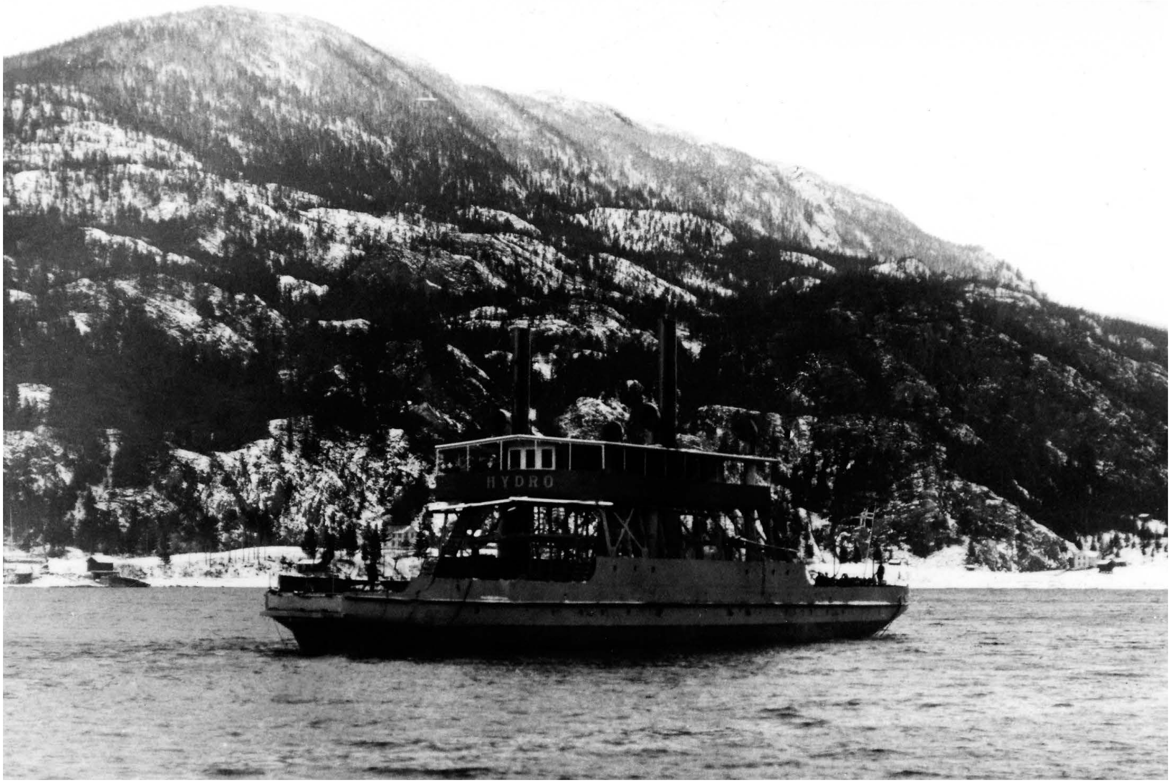
With Sørlie and Lier-Hansen, Haukelid started out for the ferry, armed with Thompson and Sten guns. Lier-Hansen went first; if there were German guards on the dock he was to fire a few shots further up the road to get them to move off in order that the other two could get on board unnoticed; however, he observed no guards outside their barracks. Haukelid led the way on board the ferry; all three were ambling as if they were going to sleep off a heavy night out on the ship. They went down the companionway to the passenger saloon. They passed the crew gathered around a table in their quarters. Only the engineer and stoker were working in the engine room. They went over to a hatch in the passenger saloon that led to the bilge, but before it was opened they heard a member of the crew leave the crew room and enter the passenger saloon.

Haukelid and Sørlie hid; Lier-Hansen with his pass brazenly stood his ground and recognised the crewman as John Berg from the athletics club. Lier-Hansen realised that he was sympathetic to the resistance and when Haukelid and Sørlie appeared from hiding, Lier-Hansen told him that they needed to hide something from the Germans, as a raid on the resistance was expected. Haukelid had the 12ft of explosives wrapped beneath his coat; his pockets full of detonators and wire, and a Sten concealed in his clothes. Berg was keen to help; the ferry had been used to hide weapons and people before, and he offered the bilge as a hiding place.

Haukelid and Sørlie went through the hatch as Lier-Hansen chatted with Berg. They crawled through the bilge on hands and knees. Iron plates covered the floor and could be removed, but water was everywhere in the bow and the explosives had to be placed closer to the passenger saloon than planned. The two alarm clocks were taped to girders on the side of the ship where the hull was dry, in order that the tape would hold. The 12ft of explosive was placed in a circle on the hull and two fuses tied on each end that were then taped together. The loose end of the tape was then attached to the alarm clocks. Haukelid set the clocks to ring at 1045hrs and wired in the electric detonators into the clock circuits. The bell hammers were

20 FEBRUARY 1944

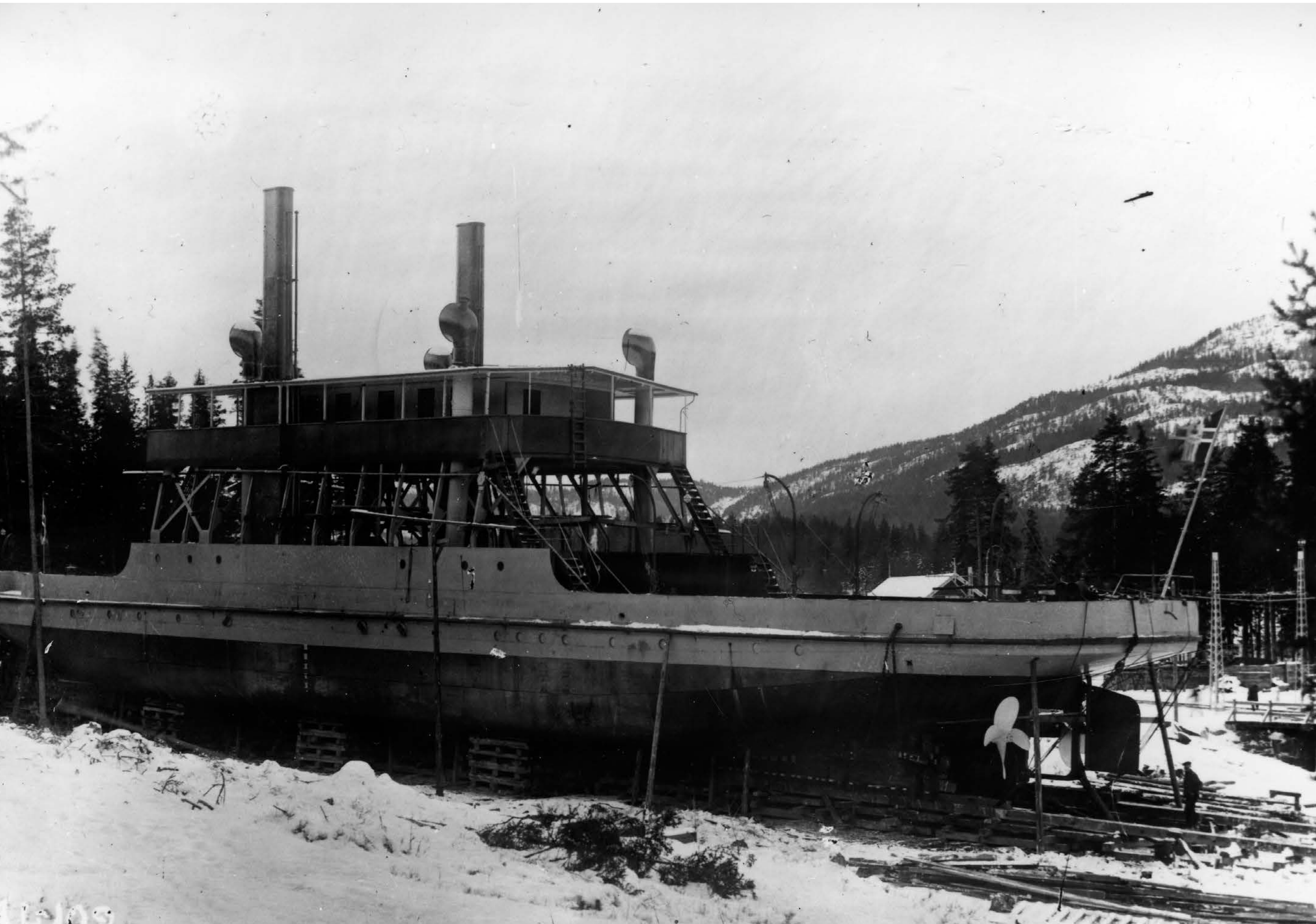
The ferry *Hydro*, carrying the last heavy water towards Germany, is sunk by saboteurs



Haukelid at first suggested forcing the crew of the Hydro to scuttle but there was no guarantee they would cooperate. German sentries would be on board and would resist if Haukelid tried to seize the ship. The other option was to plant a time delay device. Here *Hydro* is seen on Lake Tinnsjø. (Norsk Industriabeidermuseum. Foto: Ukjent) separated from the copper plates by a third of an inch. Haukelid connected the clocks to the detonator caps to complete the device. Berg asked whether they were going to stay on board for the early-morning trip to Tinnoset. Haukelid said they had to fetch some things first before they boarded. They checked whether Berg would be on the ferry and he said he was off duty.

Lier-Hansen recalled how they heard the train whistle and hurriedly made their way off the ferry. They returned to the car 3 minutes before Larsen was told to leave and started off towards Kongsberg. At Miland, Sørlie got out and skied onto the plateau as he was going to join Skinnarland. Lier-Hansen also stopped the car 4 miles from Kongsberg and Haukelid and Larsen walked into town to catch a train to Oslo. He then drove to Mael and waited until the ferry departed to make sure the Germans did not remove the cargo from the railcars. In this event, Lier-Hansen was to sneak on board and remove the explosives.

Soon after 0800hrs the train departed Rjukan with seven railcars of ammonia. Haukelid and Larsen were then on a train to Oslo. They observed Muggenthaler at Kongsberg station and hid from his view. Soon after 1000hrs the ferry, with Captain Erling Sorensen in charge, departed and halfway into its 14.9-mile journey, at 1045hrs, he was descending the ladder to the main deck when a muted roar was heard from the bow; the explosives had detonated and smoke started to appear. Thirty-eight

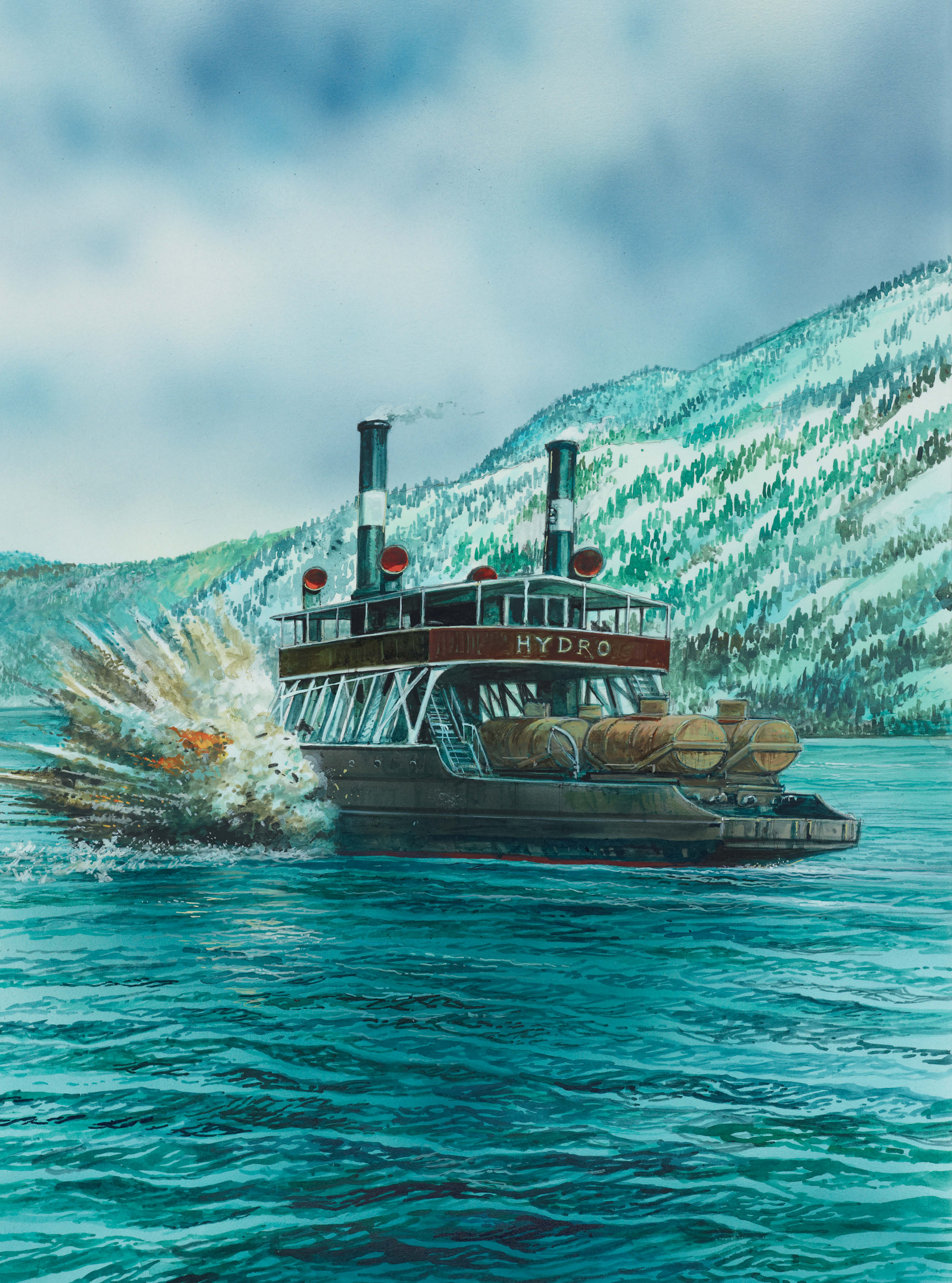


The *Hydro* ferry was flat bottomed and had a broad angled bow in order to break ice. Tracks along the main deck could accommodate 12 railcars and 120 passengers could be carried in a room below this deck. Haukelid had a tour with the ferry engineer and observed the two 250hp engines at work. Here the *Hydro* is seen out of the water. (Norsk Industriabeidermuseum. Foto: Ukjent) passengers, seven crew and eight German guards were on board. Sorensen tried to steer for shore, but the bow was soon under water. He shouted for the passengers to get into lifeboats, but some jumped into the lake. The ship keeled over to port and soon the crew could walk on the starboard side. When Sorensen entered the water the stern was very high and the propellers were still working above the surface. Then the ship sank bow first, 1,640ft from the shore. The railcars had broken loose and with the drums of heavy water had plunged into the lake. Twenty-seven people, including four guards, had jumped into the lake and were saved; 26 others, including the four other guards, did not survive. Only four half-empty drums of heavy water surfaced.

On Monday Sørlie reached Skinnarland's cabin at Nilsbu; Lier-Hansen returned to work in Rjukan; Nielsen was in hospital; and Haukelid and Larsen were travelling to Sweden. Haukelid would return to Norway after transporting Larsen to safety. Syverstad had fled to Scotland and was recruited by SOE. The Germans reported that the sinking of the ferry probably happened by accident. They were keen to absolve themselves of any culpability. Only two barrels of heavy water were recovered by the Germans.

Sinking the heavy water (overleaf)

The explosives that were laid by Haukelid and Sørlie in the bilge of the *Hydro* ferry while the ship was docked at Mael the previous night have detonated. The ship had sailed at 1000hrs on 20 February and the alarm clock detonator was set to 1045hrs, when the ship would be at the deepest point of Lake Tinnsjø. Thirty-eight passengers, seven crew and eight German guards were on board. The two railcars carrying 39 drums of heavy water would break loose and plunge into the lake when the ship's stern was raised. The *Hydro* would then sink bow first 1,640ft from the shore. Twenty-seven people including four guards would jump into the lake and be saved; 26 others, including the four other guards, would not survive.


HYDRO

CONCLUSION

SOE's achievements in successfully destroying the heavy water production facilities at the Norsk Hydro Plant in Vemork established the organisation's reputation for the rest of the war. At first an operation carried out by a small group of saboteurs was not thought feasible, and that is why a larger force was initially sent to destroy the plant. The revelations that this botched operation gave to the defenders about the Allies' intentions regarding Vemork increased the security provisions they invested in the plant. With heightened security in place the determination still within SOE to embark on the destruction of the heavy water is laudable. The fate of their men if discovered would have been indescribable. Yet realising the potential of faultless intelligence provided by workers in the plant they fully believed operational success was within reach.

Intelligence provided by insiders within the plant and sent by courier by local SOE operatives to London gave the operational planners detailed layouts of the facility, including the method by which the saboteurs could enter the electrolysis room – via the cable duct – without revealing their presence by blowing the door wide open. The depth and detail of the human intelligence was only achieved because the workers at the plant were not loyal to their occupiers and SOE had gone to the trouble to insert personnel that could task the agents and send the information to London. Aerial photographs provided details about the route that could be used to approach the plant, but only an on-the-spot reconnaissance could ensure that the route suggested by Tronstad – via the gorge – could be climbed in the weather conditions that were prevailing at the time. The planners gave the raiders flexibility to decide whether this route was feasible and whether the attack, with the most recent information about the defences provided by the resistance, offered any hope of success. Imagery did not provide the level of detail about the security measures that would have made an assault over the bridge unlikely to succeed.

The raiders realised their chances of getting in were good, but getting out was going to be a different problem and some were resigned about their chances of escaping. Whether they did or did not get out would not have necessarily affected the success of the operation, but the continued presence on the Hardanger of personnel that could liaise with SOE agents at the plant provided an uninterrupted flow of intelligence about the efforts the Germans were making to bring the plant to full production. These personnel, capable of avoiding the German counter-intelligence efforts and ground searches, were then able to mount an operation to interdict the movement of the heavy water when the Germans decided to move production to Germany, and this meant that SOE did not have to send another team. The inhospitable nature of the terrain and the survival skills of the SOE team, chosen from men that were familiar with this terrain, made them elusive opponents. The German response to the raid was not subtle enough and most of the soldiers committed to the search on the Hardanger were not specialists in this environment. The benefits of hiding on the Hardanger, despite the intense cold and barren landscape, were preferable to remaining in Rjukan or in other villages that could be searched at a moment's notice.

Although the SOE team were reduced by those that were ordered to escape to Sweden, those that did stay were capable of organising the attack on the *Hydro*, as they recruited local resistance operatives to assist them. The best place for the attack was obvious to those with local knowledge of the area. Again, the use of agents to not only provide information about the shipment but also in this case to delay when the shipment of heavy water

In March 1945 Syverstad and Skinnarland had captured Torgier Longnvik, a Nazi-appointed sheriff in Rauland; both Syverstad and Tronstad were questioning him in a cabin when his brother Johans burst in. Shots were fired by Johans; Syverstad was hit and Tronstad tried to bundle him out of the way but was also hit. The brothers escaped and Skinnarland was called. Neither Syverstad nor Tronstad survived. Here, Skinnarland and Tronstad are seen in southern Norway in the winter of 1944/45. (Norsk Industriabeidermuseum. Foto: Longum, Per) departed the plant (to ensure only the *Hydro* ferry would be used) was something to which SOE was not averse. Having access to a friendly local population to assist with the detonator of their explosive device enabled them to mount the attack within days of being ordered to do so.

At the end of the war in May 1945, despite the setbacks suffered at the hands of SOE in Norway, a plant in Bavaria was discovered that had nearly sufficient heavy water to develop a bomb. In the opinion of SOE historian M. R. D. Foot, the raid was of cardinal importance and alone justified the existence of the organisation. Von Falkenhorst called the attack on Vemork the finest coup he had seen in the war. Kurt Diebner thought the raid was the main reason why the Germans' atomic programme failed to achieve the conditions necessary to sustain an atomic reaction. Despite the attacks on the heavy water, the Germans persisted with their research until the end of the war. In early 1945 the programme was still continuing, but it had limited quantities of heavy water to use. The site at Haigenloch–Hechigen had 2 tons of uranium that needed 700 litres (153.9 gallons) of heavy water to go critical. This amount was sunk on the *Hydro*, although most of that supply needed further refining to be used. The Allies still took the threat seriously and launched a bomber attack on the uranium ore facility at Oranienberg in early 1945. Ground forces then went in to secure the 1,000 tonnes of uranium ore that was found there.

German scientists thought they had no chance to build a bomb and cited infighting, not focussing on isotope separation and lack of heavy water as the main reasons why they failed. The historian Nigel West has suggested that the importance of heavy water to atomic bomb development was overstated. In August 1941 the MAUD Committee (Military Application of Uranium Detonation) advised the War Cabinet that it thought heavy water would be important, but that research had found its usefulness was limited to processes that were not of immediate value to the war; they thought German scientists were discovering the unsuitability of heavy water in moderating the release of energy. West asserts that the attacks on the heavy water plant were part of a deception plan to encourage the Germans to continue with their research. This is incorrect. The Allies developed a plutonium bomb in a heavy water reactor as well as using graphite as a moderator.

AFTERMATH

On 5 October 1944 Tronstad was sent to Norway at his own request to recruit and organise the resistance on the plateau. With him went Poulsson, Helberg and Syverstad. Skinnarland was Tronstad's radio operator. They were preparing to stop the Germans from destroying Norway's industrial sites when the war ended. They also sabotaged arms dumps and railways. In March 1945 Tronstad and Syverstad were shot by the brother of the local sheriff that Tronstad was questioning; neither man survived.

In the summer of 1943 Rønneberg and Strømsheim began a long operation in northern Norway that would last until March 1945. In the spring of 1944 they were on Operation *Field Fare*, based near Alesund. They carried out sabotage raids against German installations in the Romsdal Valley. Poulsson was also in Norway recruiting resistance fighters; he took over command of the operation from Tronstad after the latter was shot. He stayed in the army when the war ended and by the early 1980s he was a regimental commander. Helberg was a radio operator and instructor for the resistance. After the war he became a tour guide.

Haugland was nearly caught by the Gestapo operating a radio in Oslo and had to leave the country in June 1944; after the war he took part in the Kon-Tiki expedition led by Thor Heyerdahl in 1947, sailing 3,728 miles on a 42ft balsa wood yacht to prove Heyerdahl's theory about migration. He then joined the Norwegian Air Force, rising to the rank of Lieutenant Colonel. Haukelid stayed in the army and was appointed Lieutenant General of Oslo's Home Guard. Rønneberg had a long career in the media and is the last survivor of the group.

On 8 May 1945, 40,000 resistance fighters disarmed 400,000 German soldiers. Terboven lit a bomb in his residence and killed himself. Rediess killed himself that same day. Fehlis tried to flee, but he was captured, took poison and shot himself. Petersen also killed himself in prison in 1945. Probst died before he could be tried. Von Falkenhorst was tried and sentenced to be shot, but this was later commuted to life imprisonment. He was released in 1953.

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